The Mining Magazine

PUBLISHED AT SALISBURY HOUSE, LONDON.

INDEX TO VOLUME XXIII.

FROM JULY TO DECEMBER, 1920.

EXPLANATORY NOTE.—Items in italics are names of books reviewed; illustrated articles are denoted by asterisks (*); the letters (*m.d.*) refer to notices of articles under the heading "Mining Digest."

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The Mining Magazine

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PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LIMITED AND REDUCED, AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938.* Telegraphic Address: *Oligoclase.* Codes: *McNeill,* both Editions.

BRANCH OFFICES: 420, Market Street, San Francisco. 300, Fisher Bdg., Chicago. 2,222, Equitable Building, New York.

SUBSCRIPTION 16s. per annum (Single Copy 1s. 6d.) including postage to any part of the World.

Vol. XXIII. No. 1. LONDON, JULY, 1920. PRICE 1s. 6d.

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EDITORIAL

THOSE who have the conservation of the world's oil supplies at heart are appalled at the wholesale substitution of oil for coal in the boiler-furnaces of the great ocean steamers. Our sympathies are entirely with Admiral Dumas, who, as recorded in a recent issue of the Magazine, is strongly of opinion that oil should never be used if other sources of power are readily available. But it is useless to ask the kings of commerce to foster the spirit of altruism.

MOVEMENTS are on foot for starting a new society having for its object the historical study of engineering and technology, and the "Newcomen Society" is the title tentatively chosen. Details of the scope and methods can be obtained from Mr. H. W. Dickinson, of the Science Museum, South Kensington, or from Mr. L. Pendred, editor of the *Engineer*. In these days of progress, it is well to be reminded that, while it is absolutely essential to be up to date, the best judge of what constitutes progress is the man who has knowledge of what has been done before.

THE publishing house of Charles Griffin & Co., Ltd., celebrated the centenary of its foundation on June 30. It is safe to say that no other firm of publishers has done greater service to mining, metallurgy, and the allied sciences than Griffins, and for this reason our readers will combine with us in a message of sincere congratulations on its century of usefulness, and of hope for many benefits yet to come. Personal congratulations are also due to Mr. Francis J. Blight, who has been chairman and managing director for the last twenty-five years, and under whose guidance the house has been a "phœnix" as well as a "griffin." Mr. Blight has in preparation a handsome volume recounting its history; on its publication we shall refer to the subject again.

RESEARCH fellowships in connection with the Royal School of Mines have been founded by Mr. William Frecheville, who was from 1912 to 1919 Professor of Mining. Mr. Frecheville's object is to foster research in mining, mining geology, metallurgy, and oil technology, and both the Imperial College and the mining profession will have to thank him for his large-hearted generosity. Invitations have been issued for applications for two fellowships each worth £300 for one year, possibly renewable for another year. Applicants need not necessarily be associates of the Royal School of Mines, and preferably they should be men of some practical experience. Details may be obtained by addressing the Secretary of the Imperial College of Science and Technology, South Kensington, London, S.W.7.

ELSEWHERE in this issue Mr. J. E. Clennell discusses the work done by the late S. B. Christy in connection with the electrolytic precipitation of gold and silver from cyanide solutions. Interest in this subject has been revived recently owing to the extensive experiments undertaken by Messrs. Tainton and Aymard in Johannesburg. The Central Mining and Investment Corporation has an interest in this process, and patents have of late been issued in its name. According to this process, the cathodes are porous graphite, through which the solution passes. As carbon in various forms has been used or proposed before, both with and without the electric current, it will be necessary to wait for official details before the exact nature of the process can be ascertained.

SOME time ago reference was made in these columns to the proposal to provide a home for the various technical societies in South Africa. The difficulty was, of course, the financial one, and the presidents of the societies accordingly sent their voices throughout the land calling for help from a fairy godmother or a millionaire. The three societies taking the lead in this matter are the South African Institution of Engineers, the Chemical, Metallurgical, and Mining Society, and the South African Institution of Electrical Engineers. Among other societies that are asked to join are the Association of Land Surveyors of the Transvaal, the South African Association of Analytical Chemists, and the South African Society of Civil Engineers. It is now announced that the Transvaal Chamber of Mines has come forward with the offer of the property known as the Johannesburg Club. In order to help the societies to secure these premises, the Chamber is willing to advance £10,000 and to pay interest on the mortgages for two years; also to subscribe ten shillings for every pound raised by the societies, the total not to exceed £5,000. As the premises are not sufficiently commodious, it is proposed to build two additional floors. The total cost of the premises, enlarged and furnished, is estimated at £35,000. There should be no great difficulty in obtaining a capital sum equivalent to the difference between this amount and the mortgageable value of the property.

ON another page we print an article by Mr. John B. Fern on the St. Agnes tin-mining district of Cornwall. As the man in charge at Wheal Kitty and as a pupil and nephew of the late Mr. J. H. Collins, the author has had every opportunity of becoming intimately acquainted with the formations and ore deposits in this part of Cornwall. This is not a new district, and descriptions of it have been published on many previous occasions, both in the press and in the text-books, but it is appropriate at this juncture in the history of Cornish mining to draw attention once more to the potentialities of the district. The rocks are honeycombed with metalliferous lodes, characterized by enrichments at the faults. Moreover, the faults are in steps with the downthrow against the dip, so that the lodes are repeatedly brought up toward the surface. One of these days, when large-scale mining can be undertaken, backed by adequate capital and labour supply, St. Agnes will once again become an important producer of tin.

ACCORDING to the *Engineering and Mining Journal*, the tendency nowadays in the United States is to agitate for the adoption of the metric system of weights and measures. It appears that new factories are being organized on this system, and that many of the influential engineering works are gradually making the change. This is a good omen for the metric system. The editorial comment on the subject shows an entire change of front on the part of our New York contemporary. A few years ago, when our contemporary was under different personal control, though belonging to the same publishing group, Mr. W. R. Ingalls, the then editor, sent a paper, inveighing against the metric system, to the Institution of Mining and Metallurgy. At the time we expressed dissent from Mr. Ingalls' allegations. We were at a loss to know why he should write such a paper, having some knowledge of his personal experience and predilections; nor could we understand why the Council of the Institution should adopt the views expressed in the paper. Now that Mr. Ingalls is no longer editor of our contemporary and has severed his connection with the publishing group, he might to advantage be invited to send a paper giving his own unfettered opinions of the metric system.

THE *Mining and Scientific Press* celebrated the sixtieth anniversary of its foundation in its issue on May 22. Mr. T. A. Rickard contributes to its pages an intimate history of his journalistic adventures in connection with the *Engineering and Mining Journal*, the *Mining and Scientific Press*, and THE MINING MAGAZINE. The characteristic breeziness of his style receives a re-inforcement in the shape of a number of quaint illustrations reminiscent of the "Bab Ballads." With regard to his references to those who have succeeded him at the Magazine, we have to thank him for his kindly acknowledgment of the sincerity of the work of his old assistant, and for his reference to the great increase in the number of advertising pages due to the energy, influence, and persuasivness of the present chairman and managing director. We do not agree, however, with his comment that the Magazine no longer criticizes. Our method of criticism is, no doubt, somewhat different in style from his, but as we get into hot water just as often as he did, and receive as many lawyers' letters, it is clear that the Magazine is still not without its value in this direction.

THE American Institute of Mining and Metallurgical Engineers has recently made a change in the method of issuing its publications. For thirteen years, until the end of 1919, the custom was to publish the papers in the monthly Bulletin as they were ready, and they would be formally presented and discussed at the meetings which are held twice a year. With January of this year, the official organ of the institute was transformed into a monthly magazine called *Mining and Metallurgy*, and with this, in separate bindings, were issued the papers to be presented at the meetings. In a few months, however, a further change was made. The papers are not now being sent to all the members, but only to such members as specially ask for them. At the same time brief abstracts of the papers are given in the monthly magazine. The papers will eventually appear in the yearly volumes of the Transactions. The necessity for economy in the use of paper is the cause for this alteration in procedure. Without in any way wishing to interfere in matters that do not concern us, we should like to record our own view that an economy more acceptable to technical men would be the abolition of *Mining and Metallurgy*. We can assure the Institute that readers on this side greatly miss the monthly budget of valuable professional papers, the prompt issue of which was such an acceptable feature of the society's policy.

SOME time ago we gave an outline of the first interim report of the Water-Power Resources Committee, which was appointed by the Board of Trade to estimate the water resources of the United Kingdom as applicable to the generation of electric current, and to evolve a scheme for exercising control and fostering their use. Another interim report was issued last month, in which the Committee states that water-power cannot be dealt with separately, and that other uses of water must come within the same control. The proposal now is that a central water authority, to be called the "Water Commission," should be established, preferably as a department of the Ministry of Health. Such a department would have control of all matters connected with domestic and trade water-supplies, land drainage, pollution of rivers, canals and waterways, and water-power. The idea is perfectly logical, for it is clear that in future demands for hill waters there will, for instance, be rivalry between power generation and water-supply for towns.

A Ministry of Mines.

The Government has now placed before Parliament the promised Bill for the establishment of a Ministry of Mines. The chief object of the Bill is to define the views of those now in power with regard to the extent to which the State and the employees should participate in the control and direction of coal-mining operations. For this reason the non-ferrous metal miner finds himself an unimportant person, and it is difficult for him to pick up such threads as may affect him. The outstanding feature of the Bill is that the Government proposes to nationalize the royalties, though not in this Bill, but not to nationalize the management. Another important point, which it is to be hoped will make for economy, is that the Ministry is not to be an entirely new one, but that it is to be a department of the Board of Trade, with the Minister an additional Parliamentary Under-Secretary to the Board. Besides his usual legislative and administrative functions, the Minister will have in his hands the collection of statistics, a duty now devolving on the Home Office, and he will have official cognizance of, and access to, the results of work undertaken by other sections of the Government, for instance, the Privy Council Committee of Research. As has already been recorded, the Geological Survey has been transferred to this Committee of Research and has been strengthened by the appointment of a Geological Survey Board. With regard to the control of coal mines, a number of boards, general and local, are to be established, some of them in continuance of organizations already in existence, and through their means the various points in administration will come before the workers. The committees and boards are, however, so arranged that local disputes shall be treated locally and shall be prevented from spreading into national affairs. This provision, of course, has raised antagonism among the men's leaders, who see that their weapon of the universal strike is threatened. As the coal industry of this country does not come within the scope of the Magazine, it is not desirable to discuss the Bill in detail, and as non-ferrous metal mining is only once mentioned by name, there is precious little for us to discuss anyway. No doubt by the time the Bill is through Parliament this section of mining will be better able to see how it stands. Probably all the problems open to discussion or Government advice and help will come under the general-power clause permitting the Minister to listen to any proposals, to appoint committees of advice, and to confer with other departments of the Government. But it must be admitted that to the lead, zinc, and tin mine-owners the Bill is distinctly disappointing.

A University Degree.

In the last issue of the Magazine, when writing of the desire of the Imperial College of Science and Technology to become a University having independent power to confer degrees, we said: "On the other hand, almost everybody else, including ourselves, would like to see the College an integral part of London University." Naturally we have received many inquiries as to the meaning of this pronouncement, and we have also received many protests as to our attitude. It is convenient to reply in general terms, rather than to deal with each individual criticism. The matter in dispute is an old one, and the arguments for and against have been thrashed out time after time, so it is little use going over them in detail once again. Moreover, the Imperial College authorities appear to be so united in their desire for an independent University that probably nothing that we or anyone else can say will cause them to modify their attitude. Nevertheless we deemed it expedient last month to register what was intended to be a final expression of opinion on our part, and to record our personal dissent from the College's policy. In view of the many inquiries we have no alternative but to give a general re-statement of our views.

The whole question resolves itself briefly into a determination of the difference between a university and a technical school. A university demands that its members shall have a breadth of knowledge of literature, history, and philosophy, and of the fundamentals of calculation and science, and also a profound acquaintance of some special subject. A technical school provides courses of study that fill the present requirements of some particular trade or profession, and avoids introducing matter extraneous to the immediate and obvious outlook of the student. At the Royal School of Mines, as at present constituted, the entrant must have a good acquaintance with mathematics, chemistry, physics, and one foreign language, but he is not expected to know much of the English language, literature, or history; in other words, he is not expected to have a first-class public school education. In order to win the right to give academic degrees it would be necessary for the Royal School of Mines to widen the scope of its entrance examination. With regard to any required change in the actual curriculum of studies, it is not desirable on this occasion to go into details. It is possible that little or no change would be necessary, though in all probability a broadening of the study of civil engineering, mechanics, and chemistry would be suggested, together with a contraction of the time devoted to discussions of the details of merely current practice in mining and metallurgy. The objects of a university education are to prepare the student for future problems rather than to make him conversant with present practice. In mining and metallurgy there are multitudes of problems waiting to be solved if metals and minerals are still to be won for the service of man and at a profit to the venturer. For this reason it is necessary that those responsible for the education of the rising generation of mining engineers should recognize the value of the imagination and provide facilities for its development.

In looking through the history of university education of this country, it becomes fairly obvious that Oxford and Cambridge cannot be taken as models for a modern university. Were it only for the fact that the terms occupy only twenty-four weeks out of the year the modern earnest man might be forgiven if he doubted the right of these two centres of learning to dictate to the aspirants in science with regard to academic recognition. On the other hand, London University was the champion of modern learning, and in spite of the opposition of the ancient universities was able to establish a degree in science. This opposition was aroused largely by the Church, which in those days controlled parliament and the government as well as all educational establishments. The history of the University of London is as heart-breaking as that of the Royal School of Mines, and when the aims and objects of the two organizations and the super-abounding talent of their respective teachers are considered, it can only be reckoned as a tragedy that terms were not arranged long ago for an amalgamation. In the history of the Royal School of Mines we find, for instance, that the University of London proposed such an absorption, but that Sir Roderick Murchison, head of the School, objected to the test in Latin. In later years the inability of Dr. Percy to accommodate himself to the views of other people with regard to the association of the School with the teaching of other branches of learning nearly wrecked the School. Space prevents an inquiry why Huxley preferred the position at South Kensington instead of using his influence to strengthen the London University, nor can we follow the various changes and proposals for changes in recent years. We hope, however, to revert to the subject in some detail when reviewing the forthcoming revised history of the Royal School of Mines and register of associates.

During these many years of inability to agree to a consolidation of the Royal School of Mines with London University, the establishment of universities kind to science has proceeded with gratifying results elsewhere. Manchester, Liverpool, Birmingham, and other towns established efficient colleges in which both ancient and modern subjects received full attention, and these local efforts have been rewarded by the granting of university powers. In the meantime London as a teaching university drags along, owing to the indifferent support of the representatives of wealth in the mother city of the Empire, and owing also to the difficulty of reconciling the views of the University and the colleges that ought to become an integral part of it. It seems like flying in the face of Providence to refuse the offers and proposals of London University. It is hardly credible that the Royal School of Mines in particular and the Imperial College in general should look askance at so great a privilege to themselves or at the opportunity presented of helping to make London University a truly great centre of learning worthy of the Empire City. In concluding these remarks we desire to say that we must not be supposed to be in any sense unfriendly to the Royal School of Mines or that our views as expressed are to be taken to be in any way derogatory of its usefulness or influence. Our principle is that education must ever go higher and that the dignity of the mining profession will be best promoted by every stride in advance.

Iron Bacteria.

Ten or a dozen years ago several chemists and geologists in this country put forward the suggestion that certain deposits of iron ore have been formed by the action of bacteria. By so doing most of them unfortunately won for themselves the reputation of being cranks or even worse, for the practical mining man utterly scouted the idea that a microscopic organism could accumulate vast quantities of inorganic matter. In fact the practical man was inclined to disbelieve the existence of bacteria at all, taking the bacterial theory to be nothing more than a cloak invented for the purpose of hiding the alleged ignorance of the physician, or at the best a dodge to create an artificial atmosphere of profundity in connection with medical science. In spite of this scoffing and insinuations of insanity, the chemists have persevered in their suggestion, and by their labours have accumulated sufficient information whereby their claims may be substantiated. The subject has been brought prominently before the scientific public recently by the issue of two monographs, one in this country and one in the United States. The first is in the form of a book entitled "Iron Bacteria," and is written by Dr. David Ellis, of the Royal Technical College, Glasgow. The other is a Professional Paper, called "Iron-Depositing Bacteria and their Geologic Relations," issued by the United States Geological Survey, and written by Mr. E. C. Harder. From these books it becomes evident that the theory is no new thing, for we find that Ehrenberg, in 1838, determined that a mass of material changing from deep yellow to red in the marshes near Berlin was composed of a great accumulation of a species of bacteria. In those days the organism was considered to be a diatom, and, following Ehrenberg's discovery, Sir Charles Lyell enunciated the law that bog iron ore was of organic origin. It was not until 1892 that the bacterial function was clearly perceived, in which year Molisch, of Jena, published the results of his investigations of many iron ores, in three of which he found definite remains of iron bacteria. It is naturally difficult to find a trace of the bacterial structure even in a loosely agglomerated deposit of bog iron ore, so that the chance of finding any remains in a consolidated rock is very nearly out of the question. Nevertheless, arguing by analogy it is permissible to suggest a bacterial origin for laterite, limonite, the oolite beds of central England, the minettes of Lorraine, and the Clayband Ironstone of the Carboniferous period.

Fortunately it is possible to reproduce the phenomena of formation and precipitation by means of laboratory experiments, which have been conducted with great assiduity by Dr. Ellis, Mr. Harder, and many others. The bacteria appear to have two distinct functions; first, to form crusts of ferric hydroxide for themselves, and second, to precipitate the oxide extraneously, both by reaction on a soluble iron salt. The two processes can be readily demonstrated in the laboratory, and it seems clear that the processes conducted under these conditions would be identical with those in nature.

It is believed that many iron deposits apparently of magmatic origin may have been deposited bacterially and subsequently melted. In this connection the suggestion of Mr. W. H. Herdsman with regard to the presence of phosphorus in most iron deposits serves to strengthen the theory. It is possible also to carry the theory further, and to demonstrate that iron ore may be precipitated through bacterial agency as sulphide, that is, precipitated extraneously, and not to form part of the bacterial sheath. It has been found that certain bacteria have the power, in the presence of decaying organic matter, of abstracting oxygen from sulphates and reducing them to sulphides, so that a possible explanation is provided of the existence of iron pyrites in shales, coal, and other stratified deposits.

It is not our intention to go deeply into the many complexities of the question, but rather to state the main principle, leaving such readers as are interested to study carefully the two books mentioned. It is well, however, to state that this precipitative power of bacteria provides explanations in many other branches of science, and is not by any means confined to the question of the origin of iron ore deposits. It is of importance in the consideration of water supply and sewage disposal, and, in fact, of almost every other problem in which water plays a part.

REVIEW OF MINING

Introductory.—The Government Bill for the establishment of a Ministry of Mines in this country has provided the chief feature of interest during the month. Unfortunately non-ferrous metal-mining receives scant attention in this Bill. The lack of interest in non-ferrous mining on the part of the Government is also evidenced by the refusal of the Board of Trade to recommend a grant of money to help Cornish mines to tide over the present crisis. The prices of all metals continue low, following on the fall of the previous couple of months.

Transvaal.—The dividends declared by producing gold mines of the Transvaal for the first half of 1920 are given in the accompanying table, together with a record of those paid for each of the three preceding half-years. It may be recalled that the mines did not become free to dispose of their gold at the market price until shortly after the second half of 1919 had commenced. Consequently the half-year just ended was the first in which the mines were able to derive benefit from the existence of a premium on gold for the whole of the period. The results are not so favourable as had been anticipated, the reason being that labour charges have risen since the end of 1919, while the gold premium has receded from the high level of nearly 50% once reached. However, as compared with the corresponding period of last year a dozen of the latest Rand dividends show improvement, while five companies have recently announced distributions which did not figure in the list for the earlier period. On the other hand, three, Simmer & Jack, Village Main Reef, and Primrose, have dropped out this time, and one regular distributor, Modderfontein B, has materially reduced its distribution. The principal features among the latest distributions are New Modderfontein's fresh record, and the considerable cut in the Modderfontein B rate, despite the official forecast last February, when the decision to sink an additional shaft was announced, that the cost of shaft-sinking and equipment could be met without interfering with the recent rate of dividend.

	2nd half, 1918.	1st half, 1919.	2nd half, 1919.	1st half, 1920.
RAND.	s. d.	s. d.	s. d.	s. d.
Brakpan	2 6	2 6	3 0	3 0
City Deep	1 6	2 0	2 9	2 6
Consolidated Langlaagte	1 0	1 0	1 6	1 0
Consolidated Main Reef	6	6	1 3	1 3
Crown Mines (10s.)	6	6	3 6	2 9
Ferreira Deep	2 3	1 6	1 0	2 0
Geduld	1 3	—	*a*	1 6
Geldenhuis Deep	6	6	1 6	6
Glencairn	1 0	—	—	—
Government Areas	3 0	3 6	4 0	4 0
Jupiter	3	—	—	—
Knights Deep	—	—	9	—
Langlaagte Estate	1 6	1 6	1 6	1 0
Mever & Charlton	12 0	10 0	14 0	10 0
Modderfontein (10s.)	24 0†	26 0†	30 0†	4 6
Modderfontein B	8 0	9 0	9 6	6 6
Modderfontein Deep (5s.)	10 0††	10 0††*c*	3 3	3 0
New Primrose	—	1 0	1 0	—
New Unified	1 0	1 0	1 0	1 0
Nourse Mines	—	—	9	9
Robinson Deep "A" (1s.)	—	—	—	2 0
Robinson Gold (£5)	1 0	5 0*b*	2 6	1 0
Rose Deep	1 6	1 6	3 6	2 0
Simmer & Jack	—	3	6	—
Springs Mines	2 6	—	—	1 0
Sub-Nigel	1 0	1 0	1 0	1 0
Van Ryn	1 0	1 0	1 6*	1 6*
Van Ryn Deep	4 6	4 6	5 0‡	5 0
Village Deep	—	—	1 3	6
Village Main Reef	—	4 6§	2 0	—
Witwatersrand Gold	1 0	1 0	1 0	1 0
Wolhuter	6	6	6	1 3
OUTSIDE RAND.				
Glynn's Lydenburg	6	6	6	—
Transvaal G. M. Estates	6	—	9	1 6

† On old £4 shares. †† On old £1 shares. *a* Scrip distribution equal to 16%. *b* Bonus. * Free of tax. ‡ Also Scrip. *c* Partly in Scrip. § Paid in Scrip.

Following on the high dividends paid by Central Mining, as recorded last month, comes a big distribution on Johannesburg Consolidated shares. The rate is 12½%, comparing with 7½% the year before and 5% for the years 1911 to 1918. This company has large holdings in diamond shares as well as in gold shares.

It is announced that Randfontein Estates has won its lawsuit against Sir Joseph B. Robinson. The plaintiff company has been awarded £215,000, together with interest at 6% from February, 1907. The case is to go to the Union Court of Appeal.

The new south vertical shaft at Randfontein Central has cut the West reef at a depth of 4,130 ft. Here the reef dips at 55°, and sampling has given 12·1 dwt. over 48 inches. The Randfontein Leader is apparently absent.

The directors of Modderfontein B have called a meeting of shareholders to consider a proposal to divide the £1 shares into four shares of 5s. each. It will be remembered that the denomination of New Modderfontein shares was altered from £4 to 10s. over a year ago, while more recently Modderfontein Deep Levels £1 shares were split into four of 5s. each.

At the meeting of shareholders in New Kleinfontein, held at Johannesburg at the end of May, the chairman mentioned that negotiations had taken place with the Brakpan company with a view of arranging for the prospecting of the Apex section by extending certain drifts from the Brakpan. Such exploration would be at a much deeper level than the present Apex workings, and would provide information useful in coming to a judgment as to the advisability of continuing the development of the Apex property. Unfortunately the Brakpan is not able to undertake this work just at present.

At the Roodepoort United no more development or shaft-sinking is to be done, owing to the impossibility of making profits. The extraction of the reserves of ore will continue as long as conditions warrant. It is rumoured that Modderfontein East is offering to buy the metallurgical equipment.

Coal has been found in the Waterberg district of the northern Transvaal, at a point 20 miles south of the Limpopo river, and 30 miles west of the Pongola. The discovery was made by the Irrigation Department while boring for water. Several bore-holes have been put down and have proved the existence of a coal seam at depths from 30 to 180 ft. The thickness has not yet been ascertained. It is reported that the coal is of excellent quality.

Diamonds.—The De Beers Consolidated has declared a final dividend for the year ended June 30 of 30s. on the deferred shares of £2 10s. each, making a distribution of 120% for the year. This is a record dividend. The Jagersfontein during the same period realized £1,257,678 from the sale of diamonds, a figure half-a-million higher than that during the previous year. The boom in diamonds, however, seems to be over for the time, and sales are at present on a more moderate scale.

Rhodesia.—The output of gold during May is reported at 46,266 oz., as compared with 47,000 oz. in April. In our pages of statistics we have given the returns of gold production in Rhodesia in ounces since the beginning of the current year, owing to the official sterling figures having been governed by estimations of the expected gold premium. The undependable nature of these official estimates is demonstrated by the figures for May, in which 46,266 oz. is valued at £403,255, or 174s. 3d. per ounce. On examination of the official report it appears that this high sterling return for May is due to the inclusion of £197,043 received as premium on the gold produced from July, 1919, to January, 1920, inclusive.

The financial settlement between the Crown and the British South Africa Company appears to be still a long way off. The Commission presided over by Lord Cave has held a long inquiry in Africa and London, and seems to be ready to give its judgment, but the Crown asks for postponements, with the object of finding new evidence. The whole affair has an unexplained air of mystery about it.

The interim report of the Falcon mine for the half-year ended March 31 shows that 79,767 tons of ore yielded 1,238 tons of copper and 14,596 oz. gold. The output was curtailed during December and January for three weeks owing to a strike. The ore reserve is given at 533,000 tons, as compared with 662,000 tons on June 30 of last year. No further payable ore has been discovered on the 11th level, and the ground is much disturbed by faults. Two winzes have been sunk 125 ft., and they are now being connected by a drift, which will constitute a 12th level. The ore so far disclosed on this lower level appears to be of much the same character as that on the 11th level. An auxiliary shaft is to be sunk at the west end of the 11th level for a depth of 300 ft. below the 12th level in order to explore the ore-body in depth.

A few months ago it was recorded that the Gold Fields Rhodesian had taken a lease on the property of its subsidiary, the Planet-Arcturus Gold Mines. The Arcturus mine has since been unwatered to the 5th level, and a drainage cross-cut is now being driven to the Slate mine. Stoping has been commenced on the 2nd level in both the Arcturus and Slate mines, and milling with 20 stamps began in June.

At Rhodesia Broken Hill the ground under the ironstone quarry is being prospected by shot-drill in the hopes of finding pyrites, a supply of which is desirable in order that the oxidized zinc ores may be leached. The main shaft is now down 109 ft. and no water troubles have arisen. The output of lead during June was 1,210, as compared with 1,250 tons in May.

Arrangements are being made for the supply of capital for developing the Bwana M'Kubwa copper mine on a large scale. The subscribers are the National Mining Corporation, Minerals Separation, and others. The Minerals Separation process has given excellent results on the oxidized copper ores, and it is on this basis that the deposit is to be treated in future.

West Africa.—No official figures are now being published by the West African Chamber of Mines with regard to the monthly output of gold. Our table in the statistics pages gives nothing since December last, though an accompanying table gives the returns published by the individual companies.

Australasia.—News from Broken Hill continues to be vague and contradictory. Various political resolutions appear to have been presented, both in and out of Government circles, but nothing has as yet been done.

The British, New Zealand, and Australian Governments are proposing to take over the guano and phosphate deposits in the Marshall Archipelago in the Pacific Ocean formerly held by the Germans, and to work them conjointly. The Marshall islands were captured from the Germans early in the war by Australian cruisers, and their disposition rests with the British Empire. The Government is providing also for the buying-out of the properties in these islands belonging to the Pacific Phosphate Co., Ltd., an English company which obtained concessions from the German Government in 1906.

The mining of sapphires at Anakie, Queensland, is showing considerable revival owing to a readier market and better prices for the stones. It is reported that a modern washing plant is to be erected.

India.—Another serious rock-burst has occurred at the Champion Reef mine. Carmichael's auxiliary shaft has been badly damaged and will as a consequence be out of operation for six months.

Cornwall.—The refusal of the Board of Trade to recommend the granting of financial assistance to the tin-mining industry of Cornwall is all the more bitterly felt as it came at a period of unexpectedly low prices for the metal. Dolcoath will be the chief sufferer, for the reserves are being rapidly depleted, and there will now be no funds for further development. Our Camborne correspondent deals with the matter fully and gives the local opinion.

The second year-book of the Cornish Chamber of Mines, published last month, reflects the characteristic energy of its editor, Mr. Harold E. Fern, who is also the London Representative of the Chamber. The book gives particulars of all the mining companies operating in Cornwall and Devon and comprehensive statistics relating to tin, wolfram, and arsenic. A particularly interesting feature is the report of evidence given before the Non-Ferrous Mines Committee by Messrs. C. Algernon Moreing, J. Faull, Josiah Paull, T. E. Bennett of the Duchy Mine, A. F. Maclaren, Ernest Terrell, J. Nile, and H. E. Fern, and by the boards of Dolcoath and Tincroft. Our Camborne correspondent makes reference to the issue of this book.

Some of the shareholders in the Calloose Tin Mines & Alluvials, Ltd., have formed themselves privately into a committee with the object of getting their money back or of forcing an investigation. Representatives of the press were not allowed to attend the meeting of these shareholders. The press is angry over this episode; but it must be remembered that the press as a whole did nothing for shareholders when the prospectus was advertised. The latest news issued by the company is to the effect that Mr. S. R. Bastard has been elected chairman on his subscribing new capital, personally and through several Nigerian companies under his control. It is surprising that Mr. Bastard should take this responsibility, after reading the articles in the Magazine, and after having had such sad experience at Poldice.

United Kingdom Output.—The following table gives the preliminary figures for the output of minerals in the United Kingdom during the year 1919:

	1918.	1919.
MINED UNDER METALLIFEROUS MINES ACT:	Tons.	Tons.
Antimony ore	1	—
Arsenic	2,225	2,450
Arsenical pyrites	458	75
Barium compound	52,914	47,951
Bauxite	9,589	9,221
Chalk	—	600
Chert, flint, etc.	2,443	2,643
Clay and shale	64,330	80,291
Copper (ore and precipitate)	1,166½	314
Fluor-spar	43.066	32,725
Gravel and sand	14,953	11,468
Gypsum	150.400	185,057
Igneous rocks	5,877	9,713
Iron ore	1,644,689	1,313,218
Iron pyrites	16,024	470
Lead ore	14,765	13.844
Lignite	150	—
Limestone (including calc spar)	196,513	198,644
Manganese ore	17,456	12,078
Ochre, umber, etc	5,180	5,517
Rock salt	113,884	90,938
Sandstone	37,459†	20,993*
Slate	33,200	44,142
Soapstone	936	688
Tin ore (dressed)	5,376	4,482
Tungsten ores	295	166
Zinc ore	8,860	6,564
MINED UNDER COAL MINES ACT:		
Barium (compounds)	9,172	7,571
Clay and shale, other than fireclay and oil shale	147,184	183,128
Coal	227,714,579	229,743,128
Fireclay	1,891,394	1,849,690
Igneous rocks	320	68
Iron pyrites	6,171	6,866
Ironstone	5,901,162	4,949,944
Limestone	1,821	2,249
Ochre, umber, etc	11	9
Oil shale	3 076,850	2,759.165
Sandstone (including ganister)	148,839‡	99,121††

* Including 10,366 tons of ganister. † Including 18,328 tons of ganister. †† The quantity of ganister obtained was 97,537 tons. ‡ The quantity of ganister obtained was 145,616 tons.

South Wales.—The South Wales spelter works have run into rough water, and the Swansea Vale and English Crown companies have stopped. The trouble began with an unauthorized strike at the plant of the first-named company. A few days after the men had gone out they apparently repented and asked to be allowed to resume, but the furnaces had by that time cooled down, and there was no inducement to re-start them. There is no money for English spelter makers under present conditions, and it is cheaper for some of them to cease operations. The English Crown company feels the pinch no less than others, and their action in giving their people notice to close on June 30 is a logical outcome of the position.

United States. — Proposals are before Congress for the consolidation of the Geological Survey and the Bureau of Mines, and their transfer to a specially created division of the Department of the Interior. This division would be under the control and direction of an Assistant Secretary of the Interior, who must be technically qualified by experience and education to exercise the power and duties imposed.

Mexico.—Villa has been stirring up hostility to Huerta and Obregon in the Vera Cruz district and Osuna has declared himself an opponent to the new government in Tampico. The latest news is that Villa has made it up with Huerta. The Mexican Railway, a London-owned organization, is to be handed over to the company after being in the hands of the Mexican government for some time.

At the meeting of shareholders in Esperanza, Ltd., the chairman gave some information relating to the Union en Cuale property, on which the company has an option. In the Chibos lower tunnel, driven through a sulphide ore-body, the average assay-value of the last 33 ft. was 16·9% zinc, 6·6% lead, 16·3% iron, 3·7 oz. silver, and trace of gold. In the floor of old workings in the La Paz upper tunnel there is a vein 2½ ft. wide, assaying 17% zinc, 3·5% lead, 8·6% iron, 77 oz. silver, and trace of gold. Surface oxidized ore on the Consuelo claims gave 6 dwt. gold and ¾ oz. silver. In the Providencia tunnel the ore averages 7·2% iron, 17 oz. silver, with traces of gold, zinc, and lead. An elaborate campaign of diamond-drilling has been initiated.

Brazil.—The most interesting feature of the report of the St. John del Rey Company for the year ended February 29 last is the news that a modification is about to be made in the method of opening up the deposit in depth. It will be remembered that the ore-body has until recently pitched at an angle of about 40° in a vertical plane, and that its development has been effected by means of a series of internal vertical shafts and horizontal tunnels. During the last few years the angle of pitch has become flatter, and at Horizon 21, which is 6,126 ft. vertically below outcrop, the angle is 19°. Mr. George Chalmers proposes, therefore, that below Horizon 22, that is, 300 ft. lower, the tunnel shall follow the pitch of the ore-body, in the country rock underneath. When the plans are finally settled we hope to give an illustrated description of the mine in depth. As regards the persistence of the ore in depth, Mr. C. F. W. Kup, the managing director, who has just returned from a visit to the mine, informs us that both in quality and quantity the ore is equal to anything in the levels above, and that the proportion of arsenical pyrites, which is the gold carrier, is if anything higher than ever.

Bolivia.—As reported in a news letter from Oruro published in the May issue, the Guggenheims have acquired the Caracoles tin property in the Quimsa Cruces district. It is now stated that the Pacuni and Huanchaca de Inquisivi properties have also been acquired. The tin deposits are rich, but the disadvantage is that they lie 17,000 ft. above the sea, an altitude which few white people can endure. A technical staff is being recruited in England.

Colombia.—During the year ended September 30 last the Pato company's dredge extracted gold worth $489,253 from 1,379,331 cu. yd. of ground. This was a yield of 35½ cents per yard, a much higher extraction than was expected. Rich patches were found in several places between drill-holes, but it has to be remembered that over most of the area there was only one hole in ten acres. The company's profit was £64,708, against which £33,690 is charged for income tax. The Oroville Dredging Co. holds all the shares. The Nechi company's dredge treated during the same period 1,386,525 cu. yd. of ground for a yield of gold worth $536,551, or 39 cents per yard. The year's profit was £61,994.

Siberia.—A cable has been received from Mr. Lessig, the manager of the Ridder mine, the property of the Russo-Asiatic Consolidated, to the effect that he was released by the Bolsheviks on April 4. He reports that the Ridder machine-shop and the railway are working, and that the Ekibastous coal mine is producing 4,000 tons per month. Development work has been resumed at the Maikain complex ore deposit, 50 miles from Ekibastous.

The Orsk company reports an attack on its property. Several of the staff have been killed and the two dredges have been badly damaged.

Spain.—The labour situation is bad in the south of Spain owing to general disaffection among the population. Rio Tinto is partly paralysed by a strike. At one time is was believed that the strike would extend to the railways and even to the banks, but so far this has not taken place.

THE ST. AGNES MINING DISTRICT

By JOHN B. FERN.

The author gives an account of the tin-mining district of St. Agnes, on the north coast of Cornwall.

HISTORICAL.—Mining operations in the district of St. Agnes, principally for tin, but also formerly for copper, have been carried on almost continuously since time immemorial. The period of greatest activity was the eighteenth century, when no fewer than twenty-five different mines were working in the highly mineralized area included in the stretch of ground from Chapelporth to Cligga Head, a distance of four miles, with a breadth of one mile from the coast line.

Although these operations have been from time to time on a considerable scale, yet even now, to quote the late J. H. Collins, a recognized authority on the ore deposits of the county, "mining there may be said to be in its infancy, and more especially as regards tin. The tin already wrought is certainly a mere fraction of what remains in situ."

Included within the area are such once famous mines as Royal Polberro Consols, where were recovered as long ago as 1750 masses of tinstone six hundred pounds in weight and more of nearly pure tin oxide, and where, according to old writers, the tin ore, consisting principally of large-grained crystals, occurred in such quantities in several parallel and contiguous veins that they could not find enough horses in the neighbourhood to carry it to the smelting house, and its abundance first led to the use of wheeled carriages for that purpose; West Kitty mine, which from 1879 to 1901, on a called-up capital of £12,500, paid dividends amounting to £135,600; Wheal Kitty & Penhalls United, which worked almost continuously for over a century, and produced since 1853, the earliest date at which statistics are available, 14,050 tons of tin concentrates, sold for the sum of £936,833.

Most of the mines have excellent past records, as far as their production of tin is concerned, the causes of their abandonment being as follow: violent fluctuations in the price of tin, which fell as low as £40 per ton of black tin in 1870-80, when many of the mines ceased operating; lack of reserves under the cost-book system of finance to meet these periods of depression, profits being divided up to the hilt every four months without regard to the future; the absence, for the same reason, of sufficient exploratory development to counteract the exhaustion of deposits already in course of depletion; and inadequate capital for development of mines.

The general history of these mines reflects the many disadvantages of the cost-book system, as well as the further disadvantage that all financially small ventures exhibit whether they be cost-book or limited liability. The

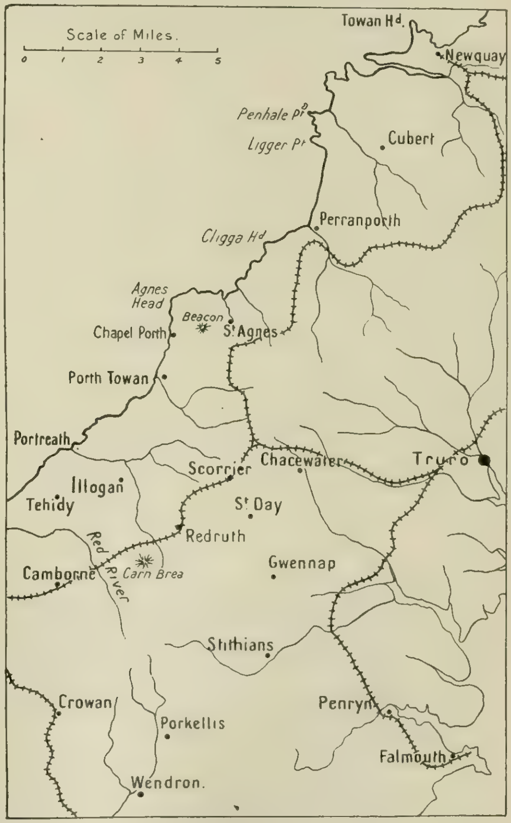


FIG. 1. MAP OF PART OF CORNWALL, SHOWING POSITION OF ST. AGNES.

former system undoubtedly did, when a small capital only was involved, possess certain advantages for a group of partners all more or less acquainted with each other and with the mine and local conditions; but the absence of a permanent and well-studied policy, the temptation to divide profits at each meeting and to avoid the provision of adequate equipment for future earnings and particularly for the de-

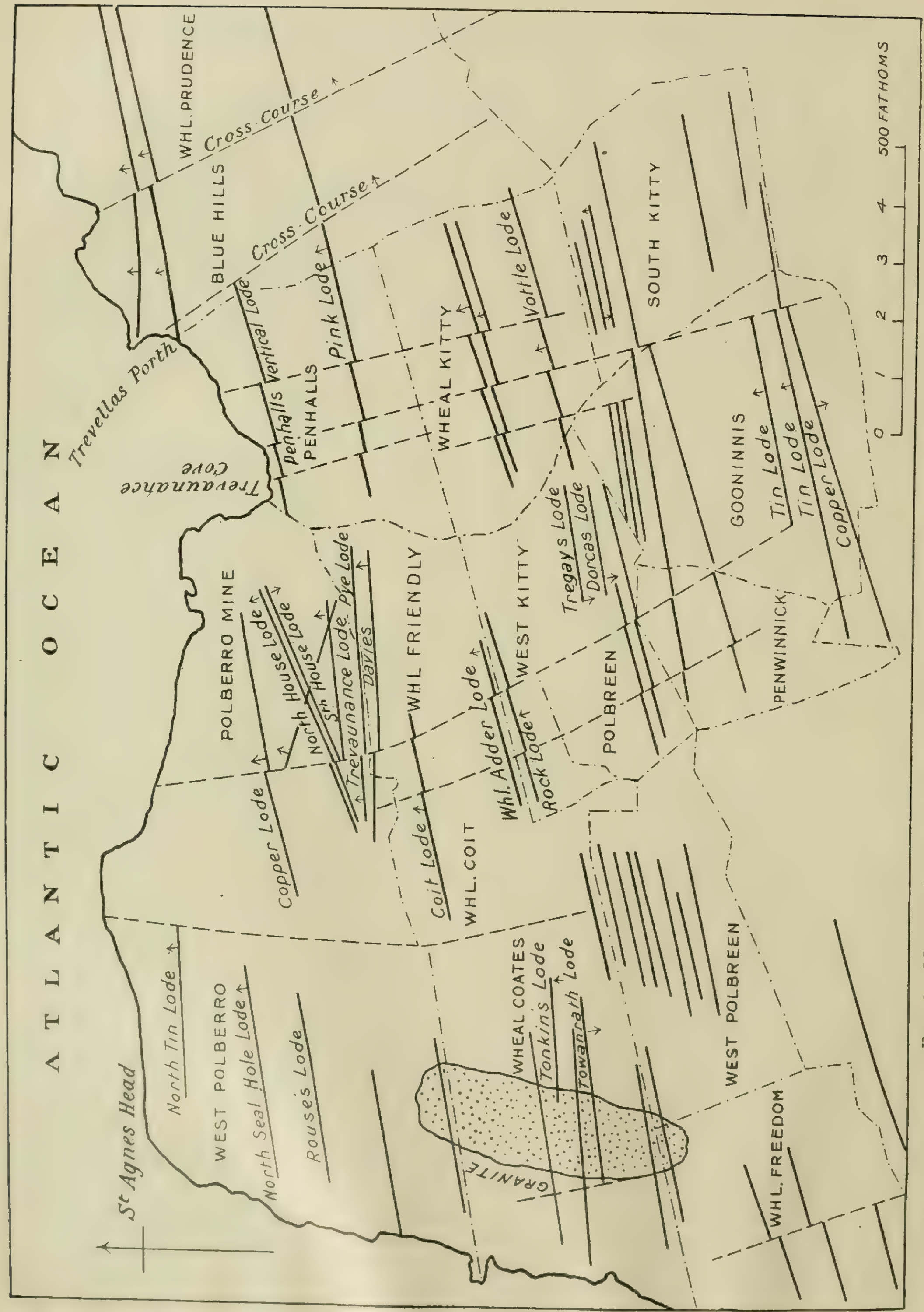


Fig. 2. Map of St. Agnes District, showing Setts, Lodes, and Cross-Courses.

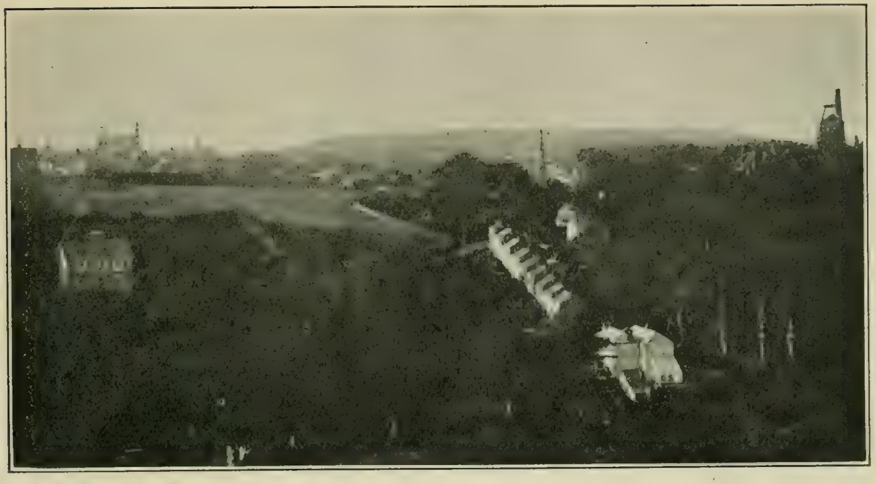


FIG. 3. VIEW OF ST. AGNES, WITH BEACON BEHIND.

velopment of new ground well ahead of present needs, together with the entire absence of reserve funds, left no choice to the companies but to close down in times of severe depression. Several of the mines seem to have started with only sufficient capital to make an ill-considered chance bid for early discovery, out of the profits of which, if successful, operations on a large scale might be initiated. In some instances the discovery of a rich and extensive ore-shoot early in the progress of the venture enabled those companies which exercised sufficient self-restraint to correct out of profits the deficiency of capital. These fortunate results, however, did not usually obtain, and many of the ventures closed down when further development became essential.

GEOLOGY.—Geologically the district is one of exceptional interest. The rocks, which have undergone great alteration since their original deposition, are recognized as belonging to the Lower Devonian series, and consist of clay slates or killas of a distinctly sandy character, passing in some instances into soft fine-grained sandstones, having silicious or cherty members showing a banded structure that are evidently

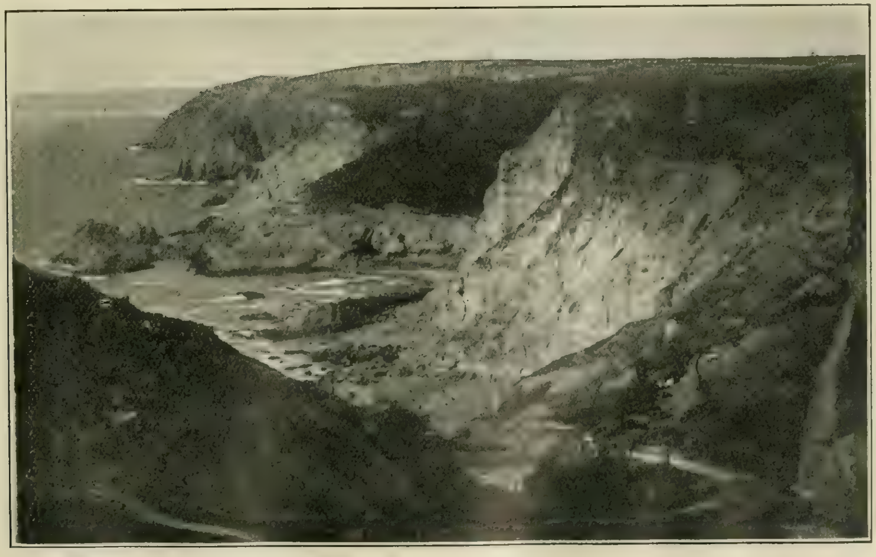


FIG. 4. THE CLIFFS AT TREVAUNANCE COVE.

the altered remains of limestone beds. The general dip of these rocks is about 18° to the south-west, with a strike to the east-north-east.

The fundamental rock is a mass of granite, which intrudes at St. Agnes Beacon on the western side of the area and at Cligga Head on the east, the killas overlying the granite which forms the connecting link between these two outcrops. The zone or aureole of metamorphism extends some hundreds of yards from the margin of the granite, the killas being bleached, and spotted with andalusite. At Cligga the granite is intersected by countless numbers of tin-bearing quartz veins, from ½ in. to 6 in. in width and from a few inches to a few feet apart, more or less parallel, and with a strike and dip conforming with that of the main tin lodes. On either side of each vein and between the granite and the quartz is a band of greisen, or altered granite, composed of quartz and mica minus the felspar, while the granite itself is often partially decomposed.

These veins also traverse the adjacent killas but do not contain tin in such quantities in the killas as in the granite, the latter where exposed in the cliffs having been honeycombed by the old workers in their search for tin. Along the northern margin of the area is a large dyke or elvan of quartz-porphyry, which may be traced along the cliffs and apparently maintains an uninterrupted course through each of the zones affected by the granite intrusions. Included within the walls of the dyke at St. Agnes Head are masses of greisen, evidence that the intrusion of the quartz-porphyry was posterior to the alteration of the intrusive granite masses. This elvan has been little explored, but where quarrying for the elvan stone has been carried on small quantities of tin have been found. Altogether the geological conditions are such as are recognized to be the most favourable for ore deposition in lodes.

Tin Lodes.—No fewer than six series of fissure veins traverse this formation in the following sequence:

(1). Oldest tin lodes underlying north with a general strike 20° north of east.

(2). Secondary tin lodes, usually underlying north but occasionally south, and coursing 20° north of east.

(3). Copper lodes, generally of southern underlie and east and west strike.

(4). Caunter tin and copper lodes striking from 40° to 60° north of east and dipping south-east.

(5). Slides underlying south and coursing approximately east and west.

(6). Cross courses, dipping usually to the east, but occasionally to the west and striking north and south.

The first series comprises the main tin lodes, which range in thickness from a few inches to several feet, the average being about 30 in. These lodes seldom have well-defined walls. There is usually a leader with capel on each side, the whole being enclosed in a disordered and metamorphosed killas country. The leader,

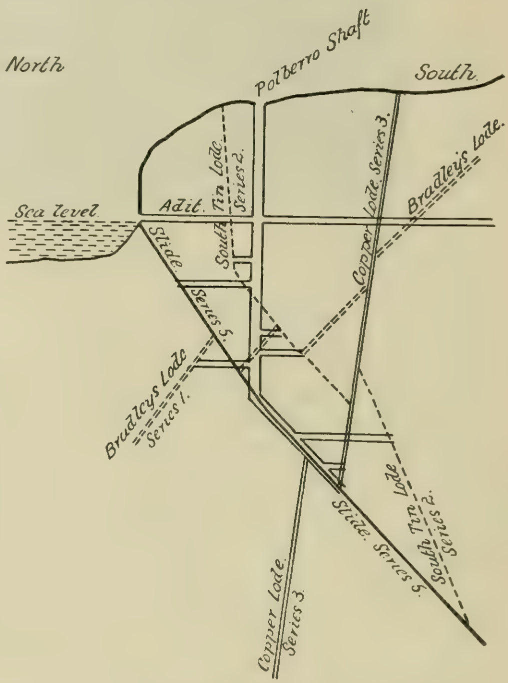


Fig. 5. Cross Section through Polberro Shaft.

containing cassiterite, quartz, iron pyrites, chlorite, schorl, and tourmaline, varies in thickness up to 20 in. or more and is often extremely rich and in some cases nearly pure cassiterite.

The capel is occasionally absent and is sometimes found only on one side of the leader, but usually on both. It is a highly altered killas, a killas which has been acted upon by mineral solutions and changed from a slaty or sandy rock into a hard compact mass of quartz and schorl, these minerals being arranged in streaks following the original lines of stratification of the killas, and, in addition, it contains numerous branches of cassiterite, tourmaline, chlorite, iron pyrites, and blende. This capel, or highly mineralized killas, extends into the surrounding country rock for variable distances, often to several feet, and sometimes contains more cassiterite than the actual leader. In mining it is worked out with the leader up to the

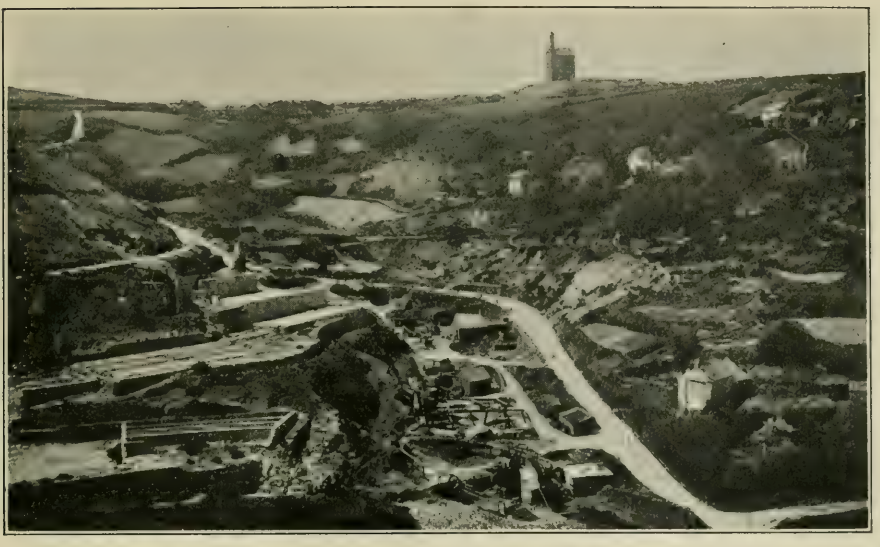


FIG. 6. VIEW LOOKING UP TREVAUNANCE VALLEY.

point at which it becomes unpayable, and consequently its working width varies from time to time with the price of the metal and the cost of stoping and treatment.

In the second series are the tin lodes which fault, and were consequently formed subsequent to, the lodes of the first series, the lode characteristics of the two series being identical.

The third series embraces the principal copper lodes, which fault, but have much in common with, the lodes of the preceding series, with the exception that their chief metalliferous component is chalcopyrite.

The fourth series contains the tin and copper lodes, which course at an angle of about 45° north of the general east and west strike, and fault slightly all the lodes of the three former series. These lodes are in general of little value, except at their intersection with other lodes, possibly having served to enrich the lodes they intersect and fault.

The fifth series comprises the slides or fault veins, composed mainly of quartz with sometimes small quantities of iron pyrites and blende, and varying in width from a few inches to several feet. These have been little explored, having where intersected contained no mineral in quantities of sufficient value to justify exploitation. Their effect is to fault, sometimes for such considerable vertical distances as 200 ft., all the lodes of the preceding series.

All the faults mentioned above are normal faults, caused by the descent of the hanging wall of the intersecting vein. An excellent example of the first, second, third, and fifth series, and the result of the faulting is illustrated by a cross section through Polberro shaft (see Fig. 5) where Bradley's lode, a tin lode of the first series, is faulted by the south tin lode of the second series, both being again faulted by the copper lode of the third series, and finally all being in turn faulted by the slide of the fifth series.

The continued formation of useful lodes up to the fourth series has resulted in repeated enrichment of the earlier members of the series, and has given rise to a great concentration of mineral wealth in a comparatively small area of ground.

In the sixth series are the cross-courses, or fault veins, which strike approximately at right angles to the veins of the other five series and fault them all in the direction of their strike. These cross-courses are composed to a large extent of crystallized quartz and contain nothing of commercial value as far as has at present been ascertained. They vary in width from a few inches to several feet and are sometimes split into branches covering several fathoms. They generally underlie to the east at an angle of from 60° to 80° from the horizon, the tendency being to flatten with depth. A correct knowledge of the result of faulting by these cross-courses is very essential to the economical development of the mines of the district, and as the effect produced has in the past been misunderstood, partly through lack of sufficient data, I propose to explain the facts relative to faulting by cross-courses in some detail.

FAULTING BY CROSS-COURSES. — The theory hitherto held has been that the faulting was caused by a direct descent of the hanging wall of the cross-courses, the result of the downthrow by a cross-course dipping east being to heave a north-dipping lode to the right hand, and a south-dipping lode to the left. This is only a theory, however, and apparently the actual result of faulting by a cross-course on two lodes of opposite underlie had been completely overlooked by those who advanced the argument. A study of the map showing the lodes and cross-courses of the district (Fig. 2) indicates both the north and south underlying lodes to have been heaved to the right hand.

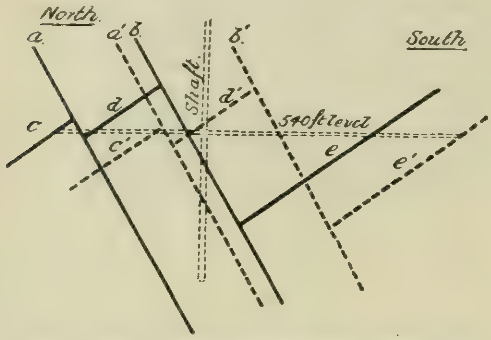


FIG. 7. ACTUAL CROSS-SECTIONS ON EACH SIDE OF THE MAIN CROSS-COURSE DIPPING EAST IN A COMPLICATED AREA AT WHEAL KITTY AND PENHALLS UNITED.

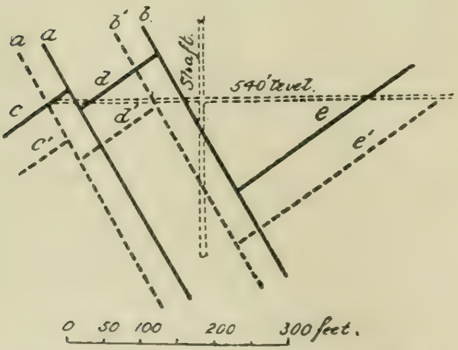


FIG. 8. ASSUMED SECTION OF THE LODES IN FIG. 7 IN POSITION THEY WOULD OCCUPY ACCORDING TO THE DOWNTHROW THEORY.

Fig. 7 shows actual cross-sections on each side of the main cross-course dipping east in a complicated area at Wheal Kitty & Penhalls United. In this figure the section west of the cross-course is indicated by continuous lines, that east of the cross-course by dotted lines, while the cross-course is assumed to be in the plane of the paper. A study of this figure shows the direction of fault movement by the cross-course to be wholly lateral, both the slides *a* and *b* and the sections of lode *c*, *d*, and *e* being thrown south an equal distance.

In comparison, Fig. 8 shows again the section west of the cross-course in continuous lines, with an assumed section east of the cross-course and on the downthrow theory in dotted lines, from which it is apparent that, if a downthrow occurred, the slides *a* and *b* would be heaved to the north and the sections of lode *c*, *d*, and *e* to the south. In view of these actual facts revealed by survey of mine developments, it is obvious that the faulting cannot have been produced by the descent of the hanging wall of the cross-course. From numerous observations I am convinced that the movement, as far as this particular district is concerned, is entirely lateral, cross-courses dipping east moving all veins crossing their strike to the right hand, those dipping west to the left hand, no matter from which side, east or west, the cross-course is approached.

This is beyond theory, and as a practical example of its correctness and importance I may mention that a few years ago, in the Vottle section of Wheal Kitty, a very productive vertical lode encountered, and was cut off by, the main cross-course. The downthrow theory was applied, and it was consequently assumed that, being a vertical lode, the displacement caused by the supposed descent of the hanging wall of the cross-course would have little effect, viewed from the strike of the lode, and that the corresponding portion of the lode would be found almost immediately adjacent on the other side of the cross-course. The latter was driven through, but the continuation of the lode was not discovered as expected, and, after a series of short cross-cuts had been put out north and south, the project was abandoned, it being considered that the lode had petered out. Some time later I had an opportunity of testing my contention that the heave was in a lateral direction. A cross-cut was driven 40 fm. to the right hand, the cross-course dipping east, and the eastern section of the lode was intersected, it having been heaved laterally, as I anticipated, exactly the same distance as the flat lodes in the vicinity. Unfortunately for us, the old men had approached this section of lode from another direction some hundred or more years previously, leaving, however, no record or outward trace of their operations, with the result that the payable ore was found to have been worked out.

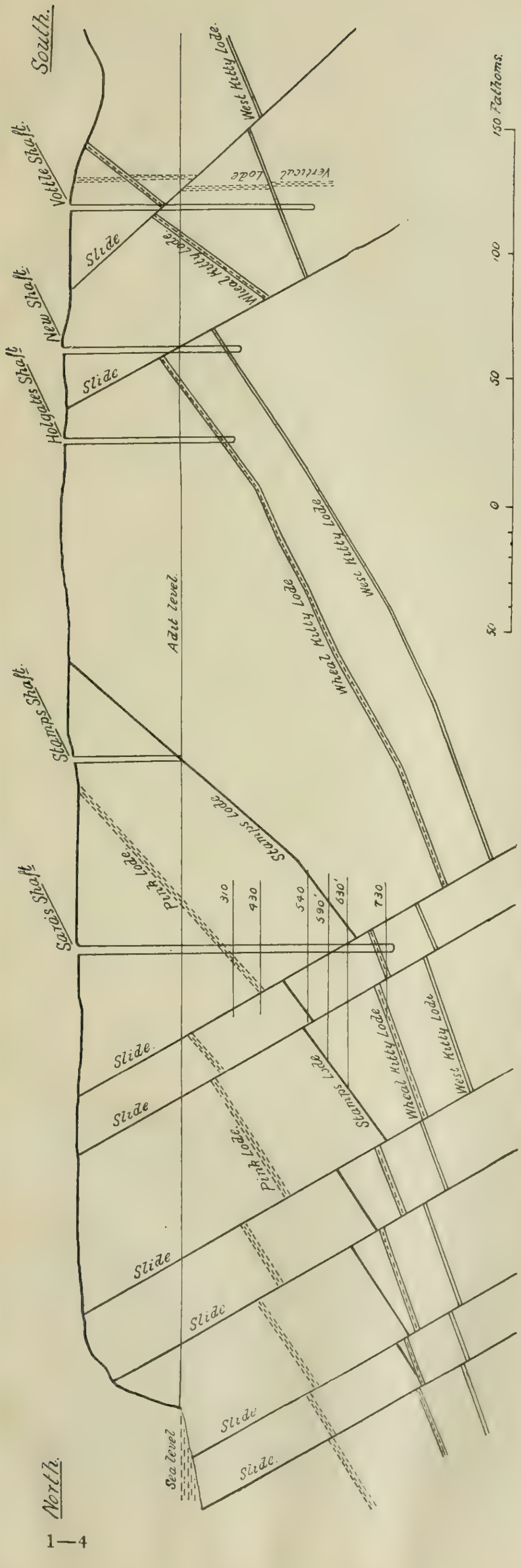


FIG. 9. GENERALIZED TRANSVERSE SECTION THROUGH WHEAL KITTY & PENHALLS UNITED.

CHARACTERISTICS OF THE LODES.—Most of the principal producing lodes are flat, from 20° to 35° from the horizon being the rule, and the effect of the faulting by the east and west series, viewed from the outcrop, is to constantly heave up the lodes in the direction of their dip, so that a very large area of lode is available at comparatively shallow levels.

For instance, in both the West Kitty and Wheal Kitty mines over 500 fm. of the main lode is available at a total vertical depth of only 130 fm. This is well illustrated in a generalized transverse section through Wheal Kitty & Penhalls mines, Fig. 9. The deepest workings at Royal Polberro Consols are only 60 fm. vertically below adit, which is at sea-level, 40 fm. below surface. This mine at one time employed over 2,000 people, and the excavations have been so numerous and extensive that a mass of rock extending over several acres and from the surface to sixty fathoms deep is slowly subsiding.

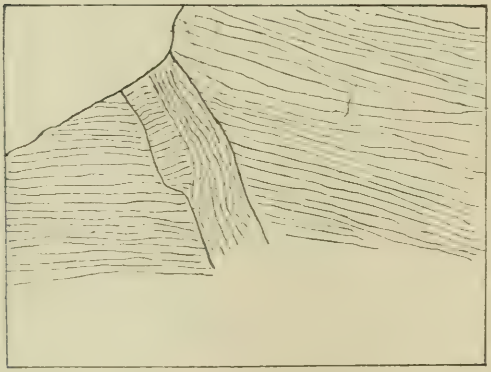
The net result of the double faulting by both east and west veins and cross-courses is to break up the lodes into relatively small blocks, and as a consequence the amount of dead development necessary to open up adequate reserves of stoping ground is greater than would be required but for these disturbances. From a commercial standpoint, however, this is off-set by the fact that the lodes are more than ordinarily rich in the vicinity of the faults, and this enrichment much more than compensates for the extra dead development necessary to pick up the faulted portions of the lodes. Moreover, the lodes are often encountered at several successive points along the same cross-cut where the latter happens to cross one or more of the fault planes, and thus the cross-cut serves for a greatly increased area of stoping ground. The tin contents of the lodes are in general very unevenly distributed, although there are certain large and fairly well defined shoots of ore, among which may be instanced a section of West Kitty lode in the Wheal Kitty and West Kitty mines which was consistently rich and of even character for a lateral distance of 300 fm. and to a depth of 200 fm. on the underlie of the lode. Away from these rich shoots, however, the patchiness of the distribution of the tin in the lodes is such that one can never safely reckon on uniformity in the composition of any block of ore developed on three or more sides if of any size. It is just as likely that a block estimated on drivage results to be rich may develop a poor core in the middle

1—4

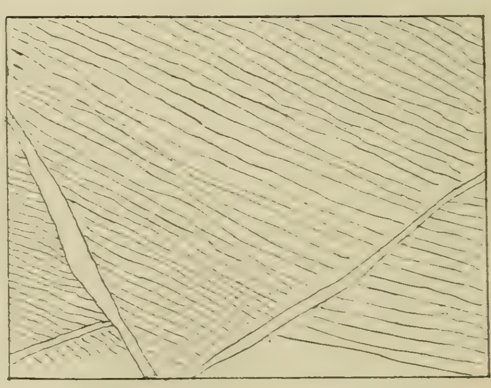
as that another block esteemed poor may be found to contain a kernel of payable tin ground. This indicates the necessity of cutting up the ground into small blocks and undertaking a large amount of development work ahead of the stoping faces to keep up uniformity in the tonnage and yield of the ore.

OUTCROP ON THE CLIFFS.—An interesting feature of the cliffs at St. Agnes is the exposure of numerous lodes, slides, and cross-courses, and many actual examples of faulting by the two latter may be seen from the beaches, for which reason the district is much sought after by students of geology.

A very rich lode traverses the small bay between the Trevaunance and Trevellas beaches, and outcrops just beyond the normal low-water mark. In years past this lode was worked from the beach when the tides were sufficiently low to allow of its being attacked, and the ore obtained was of such richness and purity that it was sent direct to the smelting works. In course of time the workings reached a depth at which it was impossible to evacuate the water therefrom in the limited period between the ebb and flow of the tide, and the work was consequently abandoned. The sand and pebbles of the beaches contain large quantities of ore from the lode, disintegrated by the action of the sea, and the beaches have been for many years and are at present being worked by streamers with considerable profit. The lode appears to be vertical and a cross-cut to intersect it was driven north from Penhalls mine at a depth of 60 fm. below the sea-level, reaching a point beneath the position of the lode's outcrop without meeting the lode, where the cross-cut was discontinued. It is more than probable, however, that somewhere between the sea-level and this depth the lode has been faulted by a south-dipping vein and thrown further north, and it would be necessary to extend the cross-cut a distance corresponding with this displacement to intersect the lode. Two photographs of cliff outcrops are given herewith in Figs. 10 and 11. In each case a sketch is appended by means of which the outcrops



EXPLANATORY OF FIG. 10.



EXPLANATORY OF FIG. 11.

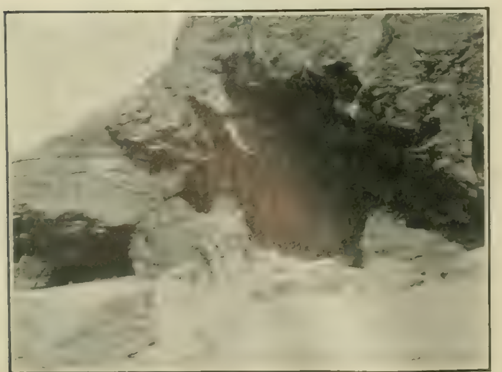


FIG. 10. OUTCROP ON CLIFF.

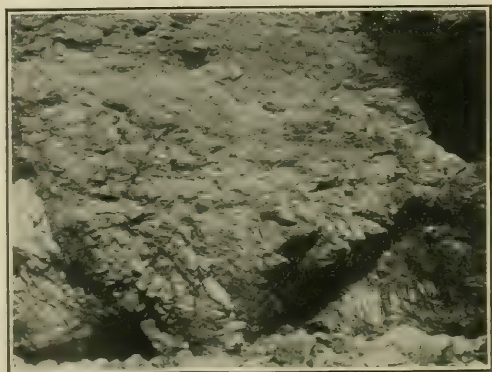


FIG. 11. FAULTING ON CLIFF.

FIG. 12. SARA'S SHAFT, WHEAL KITTY & PENHALLS UNITED.

can be traced on the photographs. Fig. 10 is a view of a portion of the cliff adjoining St. Agnes beach, and shows the outcrop of a south-dipping tin and copper lode. The lode is 6 ft. wide and contains a well defined branch of cassiterite and several branches of chalcopyrite. Its outcrop may be traced across the beach and into the cliffs on each side of the bay. Fig. 11 is a view of a portion of the cliffs adjoining St. Agnes beach, showing the actual faulting of a north-dipping tin lode by a slide, the latter dipping toward the bottom right-hand corner of the picture. The lode is faulted at its intersection by the slide, and the section of the lode south or to the right hand of the slide is heaved in a downward direction a distance of six feet.

THE MINES.—During the past few years St. Agnes has been under a cloud, and only two mines of note have been working, namely, Wheal Kitty & Penhalls United, and West Kitty, of whose history a brief record follows.

Wheal Kitty, situated between the Trevaunance and Trevellas valleys, and bounded on the north by Penhalls and the coast and on the east by Blue Hills mine, includes a number of ancient mining setts and is recorded to have employed 258 people as long ago as 1838. The principal lodes, known as the Wheal Kitty and West Kitty lodes, have an average dip of 30° from the horizon and run parallel through the property at a vertical distance apart of about 30 fm. They have been extensively worked in a lateral direction and almost from their outcrops to a depth of 130 fm. vertically from the surface, at which point a slide was encountered in 1906. At this time, after periods of brilliant prosperity and others of adversity, the old cost-book company came to an end, and a limited liability company was formed with the object of also acquiring the Penhalls sett to the north of Wheal Kitty, which contains the downward extension of the Kitty lodes, and sinking a new shaft on the boundary of the two properties to intersect the continuation of the main lodes north of the great slide. This was effected, and Sara's shaft, the largest and best-equipped shaft in the district, and one of the finest in the county, after passing through the Pink lode (Penhalls main lode) and the Stamps lode, reached the heaved northern section of the main Wheal Kitty lode at 120 fm. from surface.

At this level the lode for some distance west was exceptionally rich. The backs on it, however, were limited to about 20 fm. in extent by the position of the main slide (see Fig. 9), south of which the lode was worked out, and the area of stoping ground available was further shortened by the slide making an acute angle with the strike of the lode, eventually cutting the latter out altogether at this level. It then became necessary to further sink the shaft, but the resources of the company were exhausted. The original capital, provided mainly in small instalments spread over many years and amounting to £22,227, was never sufficient to sink and equip the shaft to the 120 fm. level, this work being completed, together with the provision and erection of a new 20 head Californian battery, out of profits earned in other sections of the mine. Up to December, 1915, the profit earned amounted to £18,363, after paying £6,772 in royalties, and of this profit only £7,175 was distributed in dividends, the remainder being spent in equipment.

Pending the provision of further capital, operations were confined to the less rich lodes above, but the intervention of the war, with its heavy depletion of the underground labour force, as much as 60% being recruited from Wheal Kitty & Penhalls, led to the inevitable curtailing of essential development to meet the proportionately increased standing charges and ultimately to the suspension of operations at the end of 1918. All the machinery, however, is up to the present intact, and although the mine is filled with water, its unwatering should not be a matter of any great difficulty, as the new Sara's shaft workings are not extensive and are dammed off from the old Wheal Kitty workings. The main shaft is 15 ft. by 7 ft. inside timbers, and is equipped with a 65 in. Cornish pumping engine, operating 18 in. pitwork, together with powerful winding engines, capstan engine, and air compressor. The milling and dressing plant consists of a newly erected 20 head Californian battery, concentrating tables, slime plant, and calciner. It is a thousand pities that, with most of the spade-work completed, a mine of such proved possibilities should languish for need of adequate capital.

The Penhalls mine, mentioned above in connection with Wheal Kitty, ceased working thirty years ago, and with the exception of sinking Sara's shaft and intersecting the Wheal Kitty lode, nothing has been done in it since. The mine includes several ancient mining setts, and is remarkable for its scores of old shafts and rare and beautiful toad's-eye tin. Although it was extensively worked at a time when the price of black tin ranged from £40 to £70 per ton, it has only now reached a depth of 60 fm. vertically below adit, and is not exhausted even at shallow levels. It is recorded to have sold during the period from 1859 to 1884, 3,601 tons of tin concentrates for the sum of £213,658, the previous sales, though large, not having been recorded. The principal lodes worked were the Pink and Top lodes, which are thrown up to a shallow depth by a series of south-dipping slides, and in addition there were worked less extensively a series of vertical and steeply south-dipping lodes. These are illustrated in Fig. 13, a section through Penhalls engine shaft, which shows the Pink and Top lodes faulted by the vertical lodes and the subsequent faulting of all the slides. This is incidentally an example of complex faulting probably unequalled in any other locality.

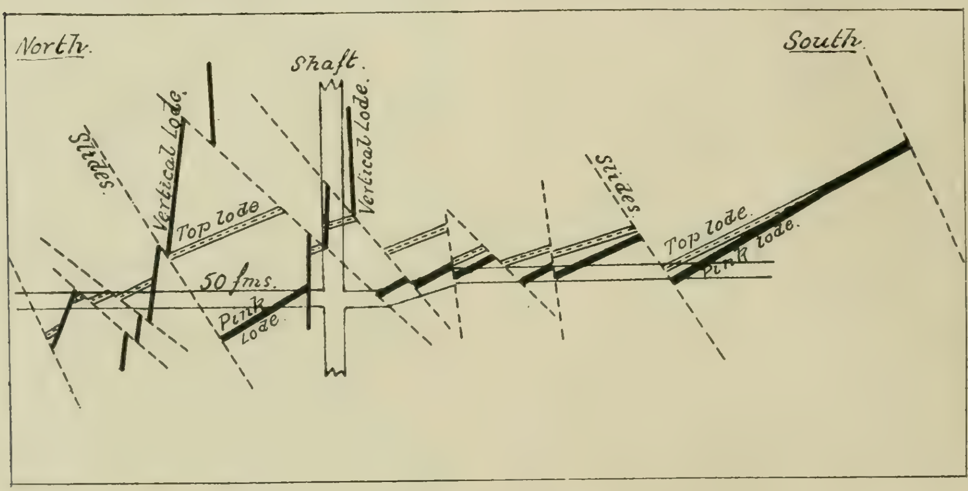


Fig. 13. Section through Penhalls Shaft.

The chief prospective value of Penhalls consists in the fact that throughout the whole area it must contain the downward extension of the Wheal Kitty and West Kitty lodes, both of which must necessarily be thrown up north by the series of slides in exactly similar fashion to the two uppermost lodes, but at a depth which, although in reality trifling, was not reached by any of the old workings in Penhalls mine.

West Kitty mine is situated on the eastern side of St. Agnes Beacon and directly beneath the town of St. Agnes. It is bounded on the north by Polberro mine and is divided on the west from Wheal Kitty & Penhalls by Trevaunance valley. Its production from 1881 to 1916 amounted to 11,124 tons of tin concentrate of the value of £773,211, and there is little doubt that if the production prior to 1881, of which there is no record, was included, the total would be well over one million sterling.

The principal lodes are identical with those of its neighbour, Wheal Kitty, and have been worked precisely as in the latter to a depth of 130 fm. vertically to the great slide. In 1909, after many years of remarkable prosperity, the production of the mine declined, and the old cost-book company was converted into a limited liability company. Under this company the sinking of Friendly shaft, which occupied a position relative to the lodes exactly similar to Sara's shaft in Wheal Kitty, was continued for the purpose of intersecting the main lode north of the great slide. The lode was met at a depth of 130 fm. and fully justified the reputation of its counterpart in the southern section of the mine, averaging, according to the reports of the management, 112 lb. of tin oxide per ton of ore over a width of three feet.

THE BEACH AT ST. AGNES.

At this time West Kitty became merged into a company called the St. Agnes Consolidated Mines, Ltd., a concern with large ideas and little capital, which was formed to amalgamate and work all the mines in the vicinity of West Kitty, with the exception of Wheal Kitty & Penhalls. The profits of West Kitty went to finance the prospecting of these other mines, with the result that when it became essential to further sink Friendly shaft, the necessary funds were not available, and, with the added difficulties caused by the war, the mine was forced to cease operations in October, 1916.

Every mining man connected with the St. Agnes district has long thought that the right policy to pursue in any future working of these mines would be to amalgamate into one concern Wheal Kitty, Penhalls, West Kitty, and Polberro, the latter containing the downward extension of the West Kitty lodes and occupying the same position relative to West Kitty as does Penhalls to Wheal Kitty. With such an amalgamation, coupled with adequate capital, under efficient and economical management, and provided that reserves of stoping ground were maintained without depletion by a due proportion of development work, the prospects of success would be unequalled in the county.

ELECTRO-DEPOSITION OF GOLD AND SILVER FROM CYANIDE SOLUTIONS.

A discussion of the late Professor S. B. Christy's work on the electro-precipitation of gold and silver from cyanide solutions.

J. E. CLENNELL, B.Sc., Assoc.Inst.M.M.

Introductory.

A melancholy interest attaches to Bulletin No. 150 published by the United States Bureau of Mines, in which the late Professor Samuel Benedict Christy details the results of his investigations on the electro-deposition of gold and silver from cyanide solutions. As stated in the introduction, this publication represents work carried on at intervals for twenty years, largely at the University of California. The latest references in the report bring the investigation down to the year 1915 (see p. 38), so we may assume that this matter was still occupying the attention of Professor Christy up to the time of his death, and represents his latest contribution to technical knowledge. The present writer first made the personal acquaintance of Professor Christy in 1897, at which time he (Christy) had already made important researches on the solution and precipitation of the cyanide of gold, and in the latest conversation he had with him at Berkeley, shortly before his death, the subject of electrolytic precipitation, and more particularly the regeneration of cyanide in that process, came under discussion. The subject is therefore obviously one to which this well-known investigator devoted a large amount of thought and labour during the greater part of his career, and his conclusions therefore merit the serious attention of all who are interested in this problem.

After giving a brief summary of previous investigations (pp. 7 to 26), Professor Christy details the experiments which led to the development of his own process, and the rest of the bulletin is mainly devoted to a description of tests made to determine the best working conditions for that process, and the various improvements in the same suggested by the results obtained.

In discussing the early history of electro-deposition (p. 8) it is rather remarkable that no reference is made to the Elkington Patent (British Patent No. 8,447, Sept. 25, 1840), which, although not referring to the treatment of ores, clearly disclosed the electro-deposition of gold and silver from cyanide solutions. This is more than 26 years prior to Rae's patent, the earliest to which Christy refers.

On the same page he announces the purpose of the report as follows: "To give an outline of some of these (electrolytic) methods as well as to show the relative advantages of the zinc and the electrical methods of recovering gold and silver from cyanide solutions." Unfortunately the latter purpose is very imperfectly carried out in the course of the pamphlet, though it is obviously the essential point of the whole matter. However excellent from a technical point of view the process of Professor Christy or any other may be, it is of no practical value unless it can compete commercially with the existing methods of precipitation by means of zinc shavings or zinc dust. Much trouble is taken in this bulletin to demonstrate the superiority of the Christy process over the Siemens & Halske and other electrical processes, but this is a matter of secondary interest, since none of these processes are now, and few have ever been, in operation on a working scale.

A number of experiments are described in detail, with diagrams giving the essential data in graphic form, and the paper contains a vast amount of interesting and useful material, but the tests given are all on a small scale and it cannot be said that the process has been adequately tried out under working conditions. The points which need to be definitely established before finally deciding on its merits are: Will the process give results in continuous operation identical with those obtained at the start? Will the electrodes resist the action of the current and the electrolyte after prolonged use? Is the process more economical in operation than other known methods of precipitation? The data presented do not afford a complete answer to any of these questions, but the results detailed are sufficiently encouraging to warrant further investigation along the same lines.

Review of Previous Processes.

Processes are reviewed (p. 13) in which an attempt is made to dissolve the precious metals in cyanide and precipitate them by electrolysis in the same vessel, in presence of the ore-pulp, so as to avoid filtration or decantation. These methods are condemned as impracticable, owing (1) to the high electrical resistance of the mixture of solution and non-conducting particles, (2) to the scouring action of the ore particles on the deposit.

An important point in connection with the theory of electro-deposition was cleared up (see pp. 15, 16), namely, the valency of gold in cyanide solutions. Christy's results prove that the metal is monovalent, not as most authorities had previously stated, trivalent. Theoretically, a current capable of precipitating 1 gm. of silver should precipitate 1·837 gm. of gold on the assumption that gold is monovalent, or 0·612 gm. if trivalent. The actual figure obtained was 1·802, a little gold being redissolved by the free cyanide necessarily present.

The weak points of the Siemens-Halske process and the reasons which ultimately led to its abandonment are discussed (pp. 17-20). The large size of the boxes used in that process was determined by the necessity of avoiding short circuits, due to the excrescences formed by corrosion of the anodes, and was unavoidable with the form of the process in use in South Africa. The low electrical efficiency, estimated by Professor J. W. Richards as not more than 0·6%, and by Christy himself at 0·3 to 0·4%, is also pointed out.

Details are given (pp. 25-26) of experiments with the Keith process, but the results of these tests soon showed that electrical processes using mercury were not likely to be successful with cyanide solutions, except for the recovery of coarse gold. The drawbacks enumerated are: (1) the use of a large amount of expensive metal, difficult to handle without loss; (2) danger of salivation; (3) necessity of overcoming the surface-tension of the metal, which makes precipitation difficult; (4) great difficulty of recovering amalgam from the large cathode area required for complete precipitation.

That low electrical efficiency is not in itself a fatal objection is shown by the circumstance pointed out to Christy by Stephen D. Field, a well-known electrical engineer, that the ordinary telephone has less than 1% electrical efficiency.

Owing to the extreme dilution of the substance (gold or silver) which has to be precipitated, a large electrode area is unavoidable, but Christy concluded that rapid and complete precipitation was to be secured by increasing the cathode area rather than that of the anode. The reason for this is that reduction rather than oxidation is required for precipitation, and since reducing actions occur at the cathode and oxidizing actions at the anode, it is desirable to extend the cathode area.

Description of Christy's Patent.

Christy's patent (U.S. Pat. 643,096, Feb. 6, 1900) describes "a process of progressive electro-concentration and recovery of gold and silver contained in the large volumes of dilute cyanide solution containing free alkali resulting from the extraction of gold and silver ores, tailings, and concentrates, which consists first in depositing the gold and silver electrolytically from said solution upon removable cathodes sufficiently numerous and large in area to secure efficient deposition, and second, in making said removable original cathodes successively anodes in a smaller volume of cyanide solution, and transferring and depositing electrolytically the thin film of gold and silver already distributed over a large number of said original cathodes upon a smaller number of secondary cathodes, also contained in said smaller volume of cyanide solution."

It will be noted that the essential idea of the process is the successive concentration of the deposit by redissolving and reprecipitating on a smaller surface, using the cathodes of the first operation as anodes in the second. An obvious advantage of this is that it lessens the cost of the final clean-up. The process does not, however, eliminate the necessity for a large precipitating surface in the first stages of the deposition.

The first problem requiring attention was to find a suitable material for the electrodes, which should be a good conductor, not too strongly attacked under the influence of the current, and should allow of easy removal of the deposit. In the first experiments (made at Bodie, California, in 1900) the current used averaged 0·135 amperes per sq. ft. of cathode surface. The cathodes were of thin sheet iron, and the anodes of iron coated with a mixture of graphite, litharge, oil, and turpentine. This protected them only at low voltages; with a pressure of 2 to 3 volts, the iron of the anodes was attacked. After deposition, the cathodes were removed and used as anodes in a smaller cell, sheets of iron coated with graphite and wax being used as cathodes, so that the deposited metal could be easily stripped.

Various impurities, such as ferric hydrate or Prussian blue, were also deposited, and the metal was only partly adherent to the cathode, much of it forming a loose deposit which had to be collected by filtering the electrolyte. The latter trouble was avoided later by circulating the solution through the deposition box.

The electrical efficiency was estimated at 2·68% (see p. 31), much greater than that of the Siemens-Halske process. This is accounted for by the possibility of bringing the electrodes near together ($\frac{1}{2}$ in. apart) without danger of short-circuiting, which could not be done with the loosely hanging lead-foil cathodes of the Siemens process, where an interval of $1\frac{1}{2}$ to 3 in. is required.

Criticisms on Christy's Process.

Christy then goes on (pp. 31-34) to discuss some unwarranted criticisms of his process, namely (1) that much gold and silver in the form of sheets must be provided, (2) that the operation of stripping in the second stage of the process must be closely watched to avoid losses of gold, current, and electrode material, (3) that neither lead nor iron can be used alternately as anode and cathode, owing to the action of cyanide upon them. The first objection does not apply, since no sheets of precious metal have to be provided. The gold or silver temporarily tied up during the process is only that which is deposited from the solution in the course of the operation. As regards the second point, with a low voltage there is no rapid corrosion of the anodes when stripping is complete, so that it is not necessary to stop the operation at the exact moment when the deposit has been transferred to the new cathodes; also any dissolved gold or silver is easily recoverable by electrolysing at a higher voltage. As to the third point, other substances besides lead and iron may be used, such as graphite and other forms of carbon, and the trouble may be largely reduced if the electrodes are in continuous use, since the main corrosion is due to the exposure of the damp electrodes to the air, which would not occur in practice. Professor Neumann, who raised the latter objection, suggests carbon cathodes in the first stage of the process, to precipitate gold from the cyanide solution, these to become anodes in the second stage, using the Wohlwill process, with an electrolyte of NaCl, $AuCl_3$, and HCl. This suggestion Christy condemns as inapplicable to solutions carrying much silver or copper.

Butters Process.

The Butters process (U.S. Pat. 756,211, April 5, 1904) is referred to on p. 35. This consists in precipitating on cathodes coated with tin, using a high-density current, with or without anodes of lead peroxide. The solution is caused to flow upward and downward between the electrodes, and a current of about 0·5 amperes per sq. ft. of cathode is used. The metals are deposited in a loose form on the tin surface and may be wiped off at intervals without removing the cathodes, the deposit being collected at the bottom of the vessel. Christy claims that his patent of 1900 discloses some features of this process, as he uses the words, "If a strong current is used, the gold is deposited on a cathode in a fine brown powder, which may be brushed off at intervals and melted down."

The Butters process has been technically successful on a large scale, but Christy points out that the high-current density required to give a loose deposit on a flat surface is wasteful, that much labour is involved in removing and wiping the plates, that there is danger of re-solution or mechanical loss of precipitate, and that the latter may be contaminated with PbO_2 from the anodes or with $CaCO_3$ separated from the solution. The last objection has some validity, but as regards labour, it may be doubted whether that involved in cleaning the cathodes would be any greater than that required in the Christy process for transferring the cathodes of the first operation to serve as anodes in another precipitation box. Christy seems to have overlooked the fact that in the Butters process it is not necessary to remove the cathodes in order to clean them. He estimates the electric efficiency of the Butters process at 5·05%, and ascribes the improvement in this respect over Siemens & Halske to the use of more suitable materials for the electrodes. E. M. Hamilton (quoted on pp. 36 to 38) gives figures ranging from 4·83 to 13·90 for the electric efficiency, but the matter is complicated by the presence of copper in the solutions precipitated in his tests.

Difficulties in Electro-deposition from Cyanide Solutions.

The next step in the development of Christy's process (p. 39) was to increase the capacity of the precipitation box by circulating the solution through it, so as to concentrate the precious metals on a smaller electrode surface than would be required for complete precipitation by a single passage of the liquid. Experiments had previously shown that a rapid consumption of cyanide occurs when a solution at rest is electrolysed with sheet iron anodes and sheet lead cathodes, and that the current falls off immediately owing to polarization and to oxidation of the anode. When the electrodes were agitated, the current immediately increased.

An interesting discussion of the difficulties involved in electrolysing very dilute solutions of the double cyanides of gold and silver is given (pp. 42-47). These are: (1) The minuteness of the quantity of metal which has to be deposited from an enormous volume of liquid;

solutions containing originally perhaps 0·001% of gold must be reduced to less than 0·00001%, an operation which becomes increasingly difficult as precipitation proceeds, so that it is impossible to remove the last traces. (2) The circumstance (discussed in detail on pp. 72-76) that the complex ions $AuCy_2$ and $AgCy_2$ are first carried to the anode, and in absence of free KCy are deposited there as a thin film, which soon acts as an insulator and prevents further action. The deposition of Au and Ag at the cathode appears to be due to secondary action of the liberated K or Na on the double cyanide in the neighbourhood of the cathode.

These considerations made it probable that circulating the solution would aid in transferring the gold or silver collected at the anode to the cathode. The original method of circulation between solid sheets placed transversely or longitudinally in the box did not secure the desired result, and the attempt was made to use perforated sheets. It was found, however, that cyanide of gold or silver tended to accumulate on the anodes in the spaces between the holes, where there was little circulation. The next suggestion was to use wire-cloth electrodes (p. 47). These not only permitted the free transfer of solution from anode to cathode, but enabled a large increase of electrode surface to be made without increasing the size of the precipitation box. Cathodes of $\frac{1}{2}$ m.m. wire cloth of 16 openings to the linear inch were found suitable, 10 such sheets arranged in 2 bunches of 5 being placed between each pair of anodes.

In view of the extreme difficulty which all investigators of this problem have encountered in finding a substance capable of resisting attack by the electrolyte under the influence of the current, the remarks on p. 48 are of interest. Christy states that "a slight film of black magnetic oxide on the anodes is an advantage, as it partly protects them from attack by the solution. With solutions free from salt and soluble sulphates the anodes are hardly attacked. Some of these anodes and cathodes that have been in use at intervals for 14 years are still serviceable."

In the first experiment detailed, a box was used having a capacity of 1·195 litres and a clear space of about 1 litre. This contained 8 anodes and 9 cathodes of 30-mesh iron wire cloth, with an immersed cathode area of $6\frac{1}{2}$ sq. in.; 8 litres of solution were used, containing 0·2% KCN and 15·87 mg. Ag per 100 cc. The current varied from 0·2 to 0·16 amp. at 1·1 to 1·25 volts, and 64·5% of the Ag was precipitated in one passage through the box. After 6 circulations, the total precipitation of Ag was 99·47%. In subsequent experiments a small centrifugal pump was used which gave the required rate of flow (about 120 litres per hour through a 1-litre box), without aeration of the solution. An air-lift is unsuitable, as aeration has to be avoided.

Experiments were mostly made with pure solutions of $KAgCy_2$ and $KAuCy_2$. In one test, salt (NaCl) was added to increase the rapidity of precipitation and it produced the desired effect, but caused a decomposition of cyanide, owing to liberation of chlorine at the anode (p. 59).

The advantage of circulation is shown by the estimate of box capacity, which is 5 tons of solution for a 1-ton box per 24 hours without circulation, and about 1,000 tons for the same period if circulated at the rate noted above. A box fitted with wire-cloth anodes and cathodes had more than 200 times the capacity of a similar box with plain electrodes.

The rapid circulation, however, soon disclosed other difficulties (p. 61). The 30-mesh wire cloth became clogged with precipitated silver which interfered with the passage of the solution, and the wire cloth anodes became coated with ferric hydrate. As a remedy for this, cathodes of 16-mesh iron wire-cloth were tried, with anodes of perforated peroxidized sheet lead. This gave rapid precipitation of silver when sufficient cathode surface was provided, but it is noted that a rusting of the iron surfaces occurred. This is ascribed to local action during the periods when the current was not passing (see p. 68), as the experiments had to be conducted intermittently, and it is supposed that this trouble would not arise in continuous operations.

Carbon anodes were then tried. These were made from electric-light carbons $\frac{3}{8}$ in. diameter, and in order to protect them from the action of the oxygen, they were soaked, 4 days in melted vaseline. They were arranged in groups of 7, fastened together by a conductor of lead, the rods being spaced $\frac{1}{8}$ in. apart and immersed to a depth of $2\frac{1}{2}$ in. The cathodes used were of 16-mesh wire cloth, having a total area of 6·59 sq. ft. The voltage was $2\frac{1}{2}$. Some action occurred at the anodes and the solution became coloured like weak tea, but was nevertheless quite effective as a gold solvent after it had been aerated. In another experiment, uncoated carbon anodes were tried, and it was found possible to use them with a lower voltage, but 1·3 volts was the minimum for effective precipitation (p. 65).

Regeneration of Cyanide.

All these experiments showed that a portion of the cyanogen originally present as $KAgCy_2$ appeared in the form of KCy as the silver was precipitated. In one set of tests (see p. 67) this regeneration amounted to 68% of the amount originally combined with silver. The recovery is thus only partial and does not compare favourably with that observed in aluminium dust precipitation, where nearly the theoretical amount is often obtained. When the current is continued after precipitation has nearly or quite ceased, other reactions set in, and cyanide is consumed by oxidation at the anodes. The resistance of the electrolyte also increases as precipitation proceeds. This is shown by the fall in the amperage (at constant voltage) and gives a means of controlling the operations without the necessity of constant assaying to determine the completeness of precipitation, since the reading of the ammeter indicates the most economical point at which to stop precipitation.

The reactions which give rise to this regeneration of cyanide are discussed in some detail (pp. 72–77). As an alkali cyanate is one of the products of the reaction at the anode, it is theoretically impossible to regenerate all the cyanogen originally present as silver or gold double cyanides in the form of available alkali cyanide. Christy's explanation of the reactions (p. 74) is as follows:

It is assumed that KCy, KOH, and $KAgCy_2$ are present in the solution in excess of the amounts undergoing electrolysis. The primary reaction in electrolysis is the separation of $KAgCy_2$ into $\overset{+}{K}$ and $\overset{-}{AgCy_2}$, of which the former travels to the cathode and the latter to the anode. The secondary reaction at the cathode is:

$$2\,K + 2\,KAgCy_2 = 4\,KCy + 2\,Ag.$$

The secondary reactions at the anode are:

(i) $2\,AgCy_2 = 2\,AgCy + 2\,Cy.$

(ii) $2\,AgCy + 2\,KCy = 2\,KAgCy_2.$

(iii) $2\,Cy + 2\,KOH = KCy + KGyO + H_2O.$

The precipitation of 2 atoms of silver is thus seen to be attended by a liberation of 4 molecules of KCy at the cathode and a net consumption of 1 molecule at the anode, so that there is actually a net liberation of 3 molecules KCy in the solution. The precipitation of 100 parts Ag thus involves a liberation of 90·27 parts KCy, instead of the total of 120·37 originally combined with silver.

The reactions in the case of gold are analogous, but the amount of KCy theoretically regenerated in the precipitation of gold is only 0·55 times that recoverable by precipitation of an equal weight of silver, the atomic weights being, respectively, Ag = 108 and Au = 197, both metals monovalent, hence the precipitation of 100 parts Au should liberate 49·65 parts KCy.

In actual practice, by using a relatively large cathode area, Christy found that more KCy than this theoretical amount could be regenerated, up to 118 parts per 100 parts of silver, and hence he supposes that some of the KCNO must be decomposed with liberation of KCy under such conditions.

Reference is made (p. 75) to the Clancy process and the regeneration of cyanide from cyanates and thiocyanates, but Christy states that when he tested this, only small traces of regeneration were observed. The present writer may perhaps mention that by electrolysis of thiocyanate in presence of sufficient alkali, with suitable electrodes, he has succeeded in obtaining KCy equivalent to 50% of the cyanogen present in KCyS. All attempts to increase this yield by continuing the electrolysis resulted, however, in gradual decomposition of the KCy formed, apparently with production of KCyO.

Christy appears to have encountered a similar difficulty, for while commenting on this advantage of electrolytic methods over zinc precipitation, he adds (p. 75), "But to take full advantage of such regeneration, the silver precipitation must not be pushed too far, for when the silver is nearly gone, electric current is wasted in decomposing the water, and the nascent oxygen set free at the anode destroys more cyanide than is regenerated at the cathode, particularly when the surface of the anode equals or exceeds that of the cathode." He also emphasizes another important point, namely, the necessity of sufficient free alkali in the process of cyanide regeneration. This will be obvious from the anode reaction (iii) mentioned above.

Experiments detailed on pp. 76-77 show that a small regeneration of KCy from K_4FeCy_6 is possible by the use of platinum electrodes.

The fact that mill solutions contain many other substances is noted, but their influence on precipitation of gold and silver and on cyanide regeneration does not seem to have been investigated (pp. 75-76).

Different Types of Electrodes.

Comparative experiments were made (pp. 78-80) to demonstrate the superiority of wire cloth over sheet-iron electrodes.

The method of concentrating the silver for the clean-up was further elaborated (pp. 80-82). It was found desirable to increase the rate of circulation on account of the increased capacity of the deposition box. Sheet-iron cathodes of two types were used, one kind perforated at the top and touching the bottom of the box, alternating with others raised from the bottom and not perforated. The wire-cloth cathodes from the deposition box were used as anodes alternating with these sheet-iron cathodes. After the silver had been collected on the sheet-iron cathodes, the stripped anodes were removed, and the perforated sheet-iron cathodes were now connected as anodes, so as to collect all the gold and silver on the plain sheet-iron cathodes, which had previously been coated with graphite and vaseline. This gave a deposit in coherent sheets which could readily be peeled off. A voltage of 0·7 was used, with 8 amperes per sq. metre (of cathode surface ?) at the start.

Special Difficulties of Gold-deposition.

The electro-deposition of gold (pp. 82-94) was found to be more difficult than that of silver, gold being electro-positive to silver, except in very weak solutions, when both metals are electro-negative to KCy. A good precipitation was obtained with pure gold solutions, but the rate was much less than with silver. The regeneration of cyanide was trifling, and was more than counterbalanced by the consumption at the end of the experiment.

Attention in drawn (p. 86) to the bad effect of allowing the gold-coated wire-cloth cathodes to undergo exposure in the intervals of use as electrodes. On resuming operations, nearly $\frac{2}{3}$ of the gold, which had become insulated by the rusting of the iron, redissolved in the cyanide solution during the first hour, but was reprecipitated on continuing treatment for a further 5 hours. An attempt was made (pp. 90-92) to remedy the effect of rust by using a special "hospital cell" in which the rusted cathodes were placed with anodes of perforated platinum or perforated peroxidized lead, using a low voltage (1·6) and circulating at the rate of 7 litres per minute. The gold at first redissolved, but finally precipitated quite satisfactorily. A higher voltage (say 2·5) would be necessary with ordinary mill solutions. Another suggestion (p. 113) is to use the rusted electrodes for a few minutes as cathodes in a cell containing a 1 to 2% solution of KOH or NaOH with a 4 to 5 volt current, which gives a violent evolution of hydrogen and rapidly reduces any oxide. In extreme cases, the iron-wire cathodes can be cleaned by heating in a closed box with H, CO, or petrol vapour, or by heating to low redness in powdered charcoal. With low voltages, the electrical efficiency of gold solutions was satisfactory.

Some attempts were made (pp. 94-97) to avoid the necessity of a special clean-up box by using pervious horizontal cathodes, above which were placed pervious anodes. By using a high voltage and rapid circulation the silver was deposited in a loose grey sponge which could be collected by scooping up with a shovel. The high voltage, however, rendered the method impracticable. A similar experiment was made with a platinum anode and wire-cloth cathode.

(To be concluded).

LETTERS TO THE EDITOR

Professional Qualifications.

The Editor:

Sir—In your last issue is published a letter under the above heading from Mr. F. P. Mennell, wherein certain views regarding qualifications for admission to membership of the Institution of Mining and Metallurgy are expressed, which are perhaps shared by others, notwithstanding that they are based on misconceptions.

In the constitution and by-laws of the Institution it is laid down that "Every candidate for admission into the class of members or for transfer into that class, shall be not less than 30 years of age and shall come within one of the following conditions:

(*a*) Five years in a responsible position, etc.

(*b*) He shall be, in the opinion of the council, by reason of his position or attainments, a desirable person to become a member."

From this it follows that Mr. Mennell's "academic geologist" in suitable cases may properly be admitted to membership. The wisdom of such a regulation is, of course, open to question, but while it exists it cannot be ignored.

With regard to Mr. Mennell's remark that membership might be used as evidence of fitness to deal with mining problems, I would point out that metallurgists in charge of large cyanide plants for at least five years have been admitted to membership in large numbers, yet that is no guarantee that they would in all cases be suitably qualified to erect or manage a copper smelter. Similarly a member qualified by management on the Witwatersrand would not necessarily be regarded as capable of handling a gold-dredging proposition. It is not necessary to give further instances to show that membership of the Institution can never be regarded as a guarantee of fitness in all branches of mining and metallurgy.

An "academic geologist" may certainly not be able to grapple with some details of mining matters, but, on admitting such to membership, careful consideration is given to personal circumstances, and the improbability of their attempting to go beyond their depth. Other members do no doubt occasionally attempt work for which they are not properly qualified, and the Institution might exercise some check in particularly flagrant cases. It would, however, be impracticable for the Institution to catalogue its members, and endorse them individually as capable of undertaking specified branches of work. The ideal world desired by Mr. Mennell and others is, I fear, unattainable, and meanwhile we must be thankful for such authority over its members as the Institution already possesses, which affords some considerable protection to the public, and will no doubt increase as time goes on. The strength of the Institution must depend largely on the general conduct and example set by the majority of its members, and such strength becomes the rod of correction for would-be backsliders.

S. J. SPEAK.

London, June 18.

Hematites of South Wales.

The Editor:

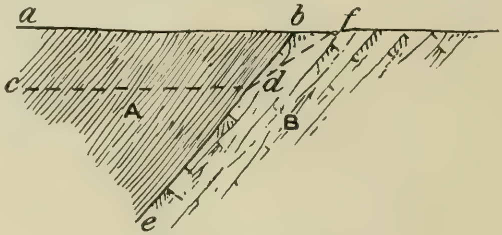
Sir—Mr. Vivian's letter of May 20, which appeared in your June issue, calls for a few words from me, if you will kindly grant the space.

Mr. Vivian is prepared to admit the possibility of a fault as I suggested, but after a statement to that effect he says: "I would, however, venture to suggest another possible explanation. Might not an erosion have occurred prior to the deposition of the conglomerate, which eroded the soft shale to a lower level that it did the limestone."

That is precisely what hitherto appears to have been assumed by other writers, but there is a difficulty in the way of it, as I pointed out in my review of Professor Sibly's Memoir.

It is inconceivable that the shale should have been worn away to the depth of the Keuper Conglomerate without making a very appreciable impression on the limestone which preceded the ore. It has not done so at other places. See Figs. 8, 9, and 10 of Professor Sibly's Memoir.

The accompanying section indicates what in my opinion might reasonably be expected to have occurred under the operation of the various meteoric denuding agents. While the shale



A=SHALES. B=LIMESTONE.

was being worn down from *a*, *b* to *c*, *d*, the limestone would be eaten back as far as the line *d*, *f*, so that instead of the hanging wall of the ore-body being the straight line *e*, *d*, *b*, as shown in Fig. 12 of Professor Sibly's Memoir, it would have a considerable bend in it, as shown by the line *e*, *d*, *f*, above.

J. D. KENDALL.

London, June 19.

Caucasus Manganese.

The Editor:

Sir—In your Review of Mining, June issue of the Magazine, you refer to a cargo of Caucasian manganese and say, "Whether this means that mining has been resumed or not is not quite clear. The probability is that the cargo came from stock." Having recently returned from the Caucasus, where I have been inquiring into the manganese industry, and arranging for shipments of manganese ore, it may interest you to hear that the industry is still practically at a standstill. The mines, as also the port of Poti, from which most shipments are made, are in Georgia, formerly Russian territory, but now recognized by the Peace Conference as a Republic. The Georgian Government has nationalized all minerals, and taken complete control of the manganese industry. Shipments of ore can only be made under contract with the Government, who will quote a price per unit on wharf Poti, to be paid on a preliminary sampling at the time of loading, and further demand a large percentage of any profit due to the difference between the price actually realized on delivery at port of destination (after due allowance for freight and other charges) and that paid prior to shipment.

At the time of my visit only one mine was working, and this was utilizing its washing plant at about one-third capacity, working one shift of 8 hours per day only.

In 1913, according to British Consular Reports, the exports of Caucasian manganese exceeded one million tons, and at the present time the stocks at the port of Poti and at the railway sidings at the mines, etc., must amount to considerably over half-a-million tons. There is one English company in the district. This, at the time of my visit, had not agreed to the Government's terms, and had made no shipments since the war.

The deposit is regular and very extensive, many of the mines are well equipped, and the district is capable of a very large output for many years to come.

W. H. RUNDALL.

London, June 24.

NEWS LETTERS

KALGOORLIE.

May 1.

The recent discovery of gold-bearing lodes at several points in Western Australia shows what possibilities there are in this State, if a sufficient number of prospectors of the newer type, that is, men who look for lodes by means of loaming, are at work. The finding of the Celebration mine gave the impetus to prospecting, syndicates were formed to provide the necessary equipment and financial backing to the prospectors, the Repatriation and Mines Departments have done their bit, and to-day there are more prospectors at work throughout the various fields than there has been for the past 20 years. The following finds show what possibilities there are ahead in Western Australia, and also what need there is for a wise administration of the Mines Department, so that the genuine prospector can not only be protected when he does make a find, but also can receive prompt technical assistance from the geological staff of the Mines Department. The prospector of to-day knows that in certain belts of country and in certain classes of rock he has a better chance of finding lodes. Travelling around the fields one is constantly being asked by prospectors, "What is the name of this rock? Is it a newer or older greenstone?" The Mines Department should be able to keep up an economic geologist on all new fields, while the prospectors should help the Department by sending in samples of ore and rock as the work proceeds.

In the past there has been a barrier between the prospector and the geologist, but this is being bridged, and as more mine managers are being promoted from mining geologists, rather than from the metallurgical side, so will the practical and scientific men work in together for the common good.

At Hampton Plains, along the main shear zone, shoots of ore have been found on the Mutooroo and Hampton Jubilee leases, in addition to that on the Celebration Lease on Block 50, and on the Jubilee Central, Golden Hope, Hansel Munday, and White Hope Leases on Block 41, while discoveries have been made to the east of the Celebration on the Pernatty lease—on one of the Hampton Properties reserve blocks north-east of the Mutooroo—and on the Tara Syndicate's lease north of the Mutooroo. Some two miles to the south of the White Hope a quartz reef, on the contact of the granite and greenstone, known as the Triangle, is being developed and has the honour of having the first crushing, which averaged over 5 oz. to the ton, since the reopening of the Hampton Plains field.

Some 40 miles, as the crow flies, south-south-east from the White Hope across Lake Lefroy is the new goldfield known as St. Ives. Here several lodes have been opened up in costeans; they consist of quartz reefs and schist in sheared greenstone. The latter is so altered that it has not yet been decided whether it is newer (gabbro and dolerite or quartz gabbro amphibolite) or the older greenstone which comprises most of the area in the Eastern goldfields. However, the Minister for Mines, at the request of the owners of the leases on the field, has despatched Mr. T. Blatchford, the Assistant State Mining Engineer, to make a report and a preliminary geological examination. His first work probably will be to sample the schist to see whether it contains a payable amount of gold, in addition to that which is found in the quartz, which in places is rich.

The question of the permanence of these lodes will depend upon these two factors, that is, the value of the schist, whether the greenstones are newer or older, together with the types of adjacent rocks. So far the writer has picked up the graphitic slates, hematite-bearing quartzites, and porphyrite similar to those found at or near Kalgoorlie, but owing to the absence of the owners, samples of schist and quartz in the lode were not obtainable for examination. It has, however, the greater similarity to the Golden Ridge series east of Kalgoorlie.

From a reefing (quartz) point of view, the field is likely to attract a considerable amount of attention from prospectors, as some very heavy and coarse gold has been obtained from some of the quartz and ironstone leaders. It is to be hoped that the Minister for Mines will see that the State Mining Engineer's report is made available as soon as possible on its possibilities. Already several regrettable incidents of lease jumping of genuine prospectors' ground by motor-car prospectors has occurred, and the Minister has to make some decisions, which are being waited for anxiously. It is understood that the Mining Act will be amended to give more protection to the man who does genuine work on ground in new country. The old diggers' law of a man holding ground on his miner's right provided he worked on it continuously is one that might still be used. In fact it would be a good thing on new finds, if prospecting areas only were allowed for say six months, and applications for leases and the consequent tying-up of ground be not entertained during that period. The reservation of certain areas for prospectors only has been suggested and will probably be included in the amendments to the Mining Act, which the Minister has promised to introduce during the coming session. This will help to get over the difficulty which now confronts him.

A further 12 miles south-south-east are situated the Paris group of mines, which are being opened up under option by one of the soundest mining engineers here, who speaks well of this line of country. If the Government were game enough to carry out a suggestion recently made at a representative meeting at Kalgoorlie to build a light railway from the present terminus at Lakeside (5 miles south-east of Kalgoorlie), through Hampton Plains around Lake Lefroy via Hogans, Victory, Ives, and Paris groups, across to connect with the Norseman line near Widgiemooltha, it would open up an immense area of gold-bearing reefs and lodes, quite capable of absorbing all the returned soldiers of this State, and numbers of ex-service men in England who are anxious to come out to our sunny land, but have not the means of doing so, as farmers.

The rush at Christmas flat, in the Monger field, is attracting considerable attention; it is situated about 40 miles south-east of Kalgoorlie and 18 miles east of Hampton Plains. This field is an old one, and has been worked for many years for quartz leaders containing high gold content, but it has only recently been boomed for its lodes. So far there have been a number of these found, but two have the pride of place among the public. McCahon, the original prospector, has sunk on a lode consisting of ironstone and quartz leaders in an oxidized greenstone schist. At 40 ft. the lode is reported to give high assay results over 16 ft. in width, and at the request of the owner is now being sampled by the Mines Department. The property is known as the Great Hope, and was floated for a quarter of a million in a few hours after McCahon gave the option, without any authentic report as to the assay-value of the lode.

The Lass O'Gowrie, some three-quarters of a mile south-south-east, has two pot holes on a "chloritized hornblendite" containing gold irregularly distributed. This is a new gold-bearing rock in Western Australia, and, being an altered hornblende, opinions are so diverse as to its permanence in depth that the general public and the owners have asked the Minister of Mines to have a report made on it at once by the State Mining Engineer. Until this examination has been completed and an official report published, it is unwise to express an opinion as to the future from a mining point of view. Meanwhile Kalgoorlie and Adelaide speculators are floating numerous companies to take up the leases pegged, but on which little or no development work has been done. Melbourne and English investors have not taken any interest in this field as yet, preferring to wait until more development work has been done in depth.

At Kanowna, which field has produced the greatest amount of alluvial gold in this State, and believed to have had its origin at the Red Hill, very interesting work is being done on the Red Hill mine. At a depth of 152 ft. the shaft sunk by the Kanowna Red Hill Company, who have the property under option, the Melba reef has been cut; it is 16 in. in width and carries coarse gold. During last year the owners took 3,846 oz. of gold from 655 tons of ore. At a higher level this lode was driven on for a distance of 350 ft. in length, and on the same lease the Big Reef has been driven on for 600 ft. in length, for an average of 25 dwt. per ton. Should these two reefs, which are in quartz-porphyry, open up as well at the present level as they did above, it will give new life to what was once a big gold-producing field. The credit of this work is to be given to Mr. D. L. Doolette, who is always ready to put money into any sound prospecting venture.

It is pleasant to report another new discovery by the returned soldier prospector, J. Cole, who has found a very promising lode at Mt. Lawrence, some 11 miles south of Wiluna.

This is said to be worth 11 dwt. per ton over a width of 10 ft., for a considerable length. Parallel to this is a quartz reef 2 ft. in width reported to be worth 2 oz. per ton. The lode formation is a ferruginous schist, and a canary-coloured formation, similar to that found on the Celebration mine at Hampton Plains, and near the surface at Kalgoorlie. It is understood that this property has been placed under option to an English company. The West Australian Gold and Silver Fields Exploration Company has a well-equipped party starting out from Wiluna to prospect the Warburton Ranges, where, according to reports, coarse gold has been found by the aborigines. This belt of country has been the Mecca of the East Murchison prospectors for many years, but the distance is great, with considerable difficulties in the matter of water supplies, so that a big expedition like the present is the only way to accomplish it. Food for a nine months' trip has been taken out, and it is to be hoped that the plucky prospectors will be rewarded.

The big lode known as Reedy's find near Cue is to be given a good trial by a syndicate of mining engineers, who have done such good work on the Lancefield. The lode is said to be amenable to cheap mining and treatment by cyanide, owing to the fineness of the gold, offering chances for working in a big way. The adjoining property has also been taken up by another sound syndicate. The options are free, and all the money put up will be used in developing the properties, which, if then satisfactory, can be floated off into companies with reasonable certainty of success. These options are a direct contrast to those at Hampton Plains, St. Ives, and Mt. Monger, where little or no sampling can be made because the lease peggers (they are not prospectors) demand 10% deposit on a high price generally, for a totally unimproved property. The procedure then is to float it off, generally without any report, the promoters to show their confidence (?) in the property by taking up most of the shares, which are then sold to the public at a considerable premium. The completion of the purchase consideration, and the money for development work will come out of calls, and as most of the companies are no-liability, the shareholders need not pay the calls, and so in a few months' time numbers of these wildcat companies will be wound up.

In the older centres the mining companies are putting up a good fight against high prices of stores and shortage of men (many have gone to the new fields), but are just able to meet the increased cost by the higher price received for gold. Now the miners consider that they should participate in this increase, and have issued a log of wages and conditions, which, if conceded, would shut down nearly every mine in the State. Thus, while the prospects for finding gold are good, those of extracting it under the rates asked for are such that may well be reconsidered by the miners before they crush the life out of the industry.

Since writing the above a new line of lode has been opened up on Hampton Properties Block 45, on which encouraging assay-values have been obtained over a considerable width. This is on the Waterfall Golden Ridge line of country east of Kalgoorlie.

C. M. HARRIS.

TORONTO.

June 12.

METALLIC PRODUCTION OF ONTARIO.—Returns received by the Ontario Bureau of Mines for the first three months of 1920 show a total metallic production of the value of $11,021,654, as compared with $10,021,654 for the corresponding three months of last year. The most noteworthy increase is in the output of gold, which was valued at $2,953,036, as compared with $2,026,536, an increase of nearly 40%. Silver showed a falling off, with a production of 2,280,665 oz., valued at $2,954,695, as against 3,105,002 oz., valued at $3,152,700 for the first three months of 1919, and most of the other items showed decreases.

PORCUPINE.—Satisfactory as the increase in gold production appears, it would have been considerably larger if the companies had been able to obtain more labour. Many men have been attracted from the gold and silver camps by the higher rate of pay obtaining at the Sudbury nickel mines. To meet competition from this and other quarters, the mine managers have increased the rate of wages by an all-round rise of 50c. per day, giving shovellers a minimum of $4·70 per day, drillers $5·25, and a proportionate advance to other employees. The new wage scale is stated to have had a steadying effect in overcoming unrest and the roving disposition recently prevalent, and conditions have become more settled.

The annual report of the Dome mines for the year ended March 31 shows that, despite some discouraging conditions, the company had, all things considered, a satisfactory year, with net profits of $951,984. The total production was $1,775,374 from the treatment of 270,080 tons of ore, the average yield per ton being $6·56. After deductions for depletion, depreciation, etc., a net surplus of $351,814 remained. The report is somewhat conservative as regards ore reserves, merely stating that the ore is sufficient to enable the company to operate the plant at capacity for three or four years. The continuity of ore-bodies has been proved to the eighth level, and diamond-drilling points strongly to the conclusion that eventually large bodies of ore will be opened up at considerable depth below the tenth level. The Hollinger Consolidated is gradually increasing its output, having brought additional stamps into operation, and is now treating about 2,000 tons of ore daily, of an average grade of approximately \$9·75, with earnings considerably exceeding present dividend requirements of 6% per annum. The North Crown will drive a cross-cut at the 500 ft. level into the Thompson-Krist property for exploration purposes. At the Porcupine-Keora the shaft is down 140 ft., at which depth a promising vein has been encountered.

KIRKLAND LAKE.—The Lake Shore during April produced bullion to the amount of \$35,388, from the treatment of 1,860 tons of ore, the recovery being about \$19·56 to the ton. While this represents a decline, the Lake Shore maintains its position as the highest grade operating gold mine in Canada. The Ontario-Kirkland has let a contract for the erection of a mill, as the downward continuation of the ore-bodies opened up on the 300 ft. level to the 450 ft. level has been proved, assuring ample supplies of ore. The size of the mill will be determined later in accordance with the results of further development at depth. At the Bidgood the shaft is down 150 ft. on an 8 ft. vein, and will be sunk to the 300 ft. level. The Kirkland Lake during May produced upwards of \$40,000. Deep mining is being undertaken with No. 2 shaft sunk below 825 ft. with a view to extensive development when the 900 ft. level is reached. Rich ore is being extracted from a wide ore-body at the 300 ft. level.

COBALT.—Labour conditions at this camp were somewhat similar to those at Porcupine, though the wages, supplemented by a bonus based on the selling price of silver, were higher. A rearrangement has been necessary on account of the drop in the silver market, and the bonus of \$1·25 per day is being continued irrespective of the decline. Cobalt is likely to be seriously affected by the low price of the metal, as when silver was high it was found profitable to treat large quantities of very low-grade material formerly not worth working. This can no longer be handled at a profit under present conditions and, unless the market shows improvement, a considerable decrease in the output may be looked for, and some of the companies may be forced to discontinue operations. During May the Nipissing mined ore of an estimated value of \$335,597 (allowing 99½ cents per oz. for silver), and shipped bullion and residue from Nipissing and custom ores of an estimated net value of \$405,746. At the Provincial a vein of high-grade ore 10 in. in width has been discovered on the 70 ft. level. A stope is being opened. Shaft No. 2 on the Oxford-Cobalt is down 90 ft. on a 5 in. vein, which widens at depth and shows good silver content. The annual report of the Peterson Lake for the year ended April 30 shows profits of \$48,299, and a total surplus of \$127,886. The company anticipates a large income from the treatment of a dump of tailing, the accumulation of many years, for which an arrangement has been made with the Dominion Reduction Co. The Timiskaming, which is now handling approximately 135 tons of ore daily, is installing a silver refinery.

MATACHEWAN.—There is very little activity in this field, claim-owners generally waiting the construction of power-transmission lines before undertaking development work. The Matachewan has done extensive diamond-drilling, and has blocked out a large amount of ore. Preparations are in hand for the erection of a mill.

FLIN-FLON COPPER MINES.—It is officially announced that the Mining Corporation of Canada is associated with W. B. Thompson & Co., of New York, in the option on the Flin-Flon copper deposits in north-western Manitoba. The property is now being explored by the sinking of shafts, and driving on the vein to confirm the results of diamond-drilling, which indicated the existence of 20,000,000 to 30,000,000 tons of copper ore. Should the option be exercised, a total outlay of \$8,000,000 to \$10,000,000 will be required for the development of the property.

CAMBORNE.

THE YEAR-BOOK of the Cornish Chamber of Mines, which has recently been published, is likely to prove not only a useful record of West of England non-ferrous mining for last year, but should prove of value for reference purposes to all interested in tin-mining. It is issued at a time when the tin-mining industry of Cornwall is under a cloud, but it loses none of its interest because of that fact. We have sufficient confidence in this highly mineralized belt of country and faith in the recuperative powers of the industry, given a return of a reasonable price for tin, to believe that a reference work of the character of this Year-book will be highly appreciated by those who, later on, will be engaged both in raising the capital and in re-starting the mines. At the moment, the feature of interest is the chief evidence of the principal witnesses representing the industry who appeared before the Non-Ferrous Mines Committee of inquiry, whose report was referred to at a length in the last issue. We can quite understand that Mr. Fern, the editor of the Year-book, felt that the facts disclosed in this evidence were of too valuable a character to rest in the archives of a Government Department, and as the committee did not consider it necessary to include this informative matter in its report, we are glad that the Chamber has gone to the expense of putting it on record. We notice, too, that the detailed statistics of the mineral production of Cornwall and Devon for 1918 are given; before the war the Home Office published the official returns of the mines in the annual blue-book prepared by the Chief Inspector of Mines, but for some unexplained reason—it cannot surely be for the sake of economy—this practice has been dropped. We are glad the Chamber has filled the breach, as such figures are most useful for reference purposes. A map of Cornwall, showing the situation of all the mines that are working, or have been worked in the past few years, is a valuable adjunct to the book. We heartily congratulate Mr. Fern on his production; he has been engaged for so many years in collecting information relating to Cornish mining affairs—first in association with the late J. H. Collins—that no man probably is better qualified to undertake a reference work of this character.

LEVANT TIN MINES, LTD.—The statutory meeting of this company was held on July 2. From the report sent to the shareholders, it would appear that three-fourths of the nominal capital of the company has been allotted, or in other words £120,000 out of £160,000. Of this, one-half, or £60,000, has been issued for cash, the other moiety being issued as fully-paid shares in consideration for the purchase of the property and by way of commission for providing the capital. It is regrettable that no progress has been made with the sinking of the new shaft and so little with the equipment of the property. Valuable months are being lost, and doubtless in the meantime the working capital is being eaten into by losses which cannot well be avoided. No policy of landward exploration only will prove permanently satisfactory at Levant. A new shaft and modern equipment are absolutely essential if profits are to be earned.

KILLIFRETH.—Further capital is to be provided for this company by means of the issue of 25,000 shares of £1 each at the net price of 16s. per share. This will bring the issued capital of this company up to £150,000, which is rather on the high side. The main purpose of the new issue is to provide funds to acquire the adjoining property of Wheal Busy and the mill and other machinery thereon. For some time past, this 10-stamp mill has been under hire to the Killifreth company; indeed during the past three months 1,850 tons of ore has been milled, showing a recovery of 42 lb. black tin per ton. This result is exceedingly encouraging. It is proposed to add a further 15 stamps, and by the time this work is completed, the management hopes to be in a position to maintain an output of 2,000 tons of ore per month. On this basis, they are sanguine enough to express the opinion that a satisfactory profit will be shown even with the existing price for tin. Already a large amount of development work has been done at the 20, 40, and 50 fathom levels, where it is reported "good payable grade" ore has been exposed. The Wheal Busy lode contains tin, arsenic, and copper, but in the upper levels the tin content is negligible. It is stated that there is an elvan course in the property impregnated with arsenic, nearly 50 ft. wide, and assaying from 0·5 to 20% arsenic. It is proposed at once to commence work on this ore-body above adit.

GOVERNMENT ASSISTANCE.—Our anticipation that the deputation to the Board of Trade arranged through the Joint Industrial Council would not meet with success has unfortunately proved only too correct, for the President of that Department has now communicated his decision to the Council stating that he is unable to recommend Parliament to vote any financial assistance to the industry. One cannot refrain from saying that in this matter the industry has been badly led. The lack of initiative, the absence of driving force, and the apparent ignorance of the powers that be as to the method of tackling the Government, are all evidence that, in the matter of tactics, those concerned have much to learn. In a matter of this kind, the battle has to be fought with the gloves off; all parties interested directly or indirectly must be united in a determination to make themselves obnoxious to the Government until, for the sake of peace and quietness, they make the industry a grant, call it a "sop" if you will; those who know the inner history of the industry for the past few years will only recognize it as reparation for injuries suffered in the interest of the nation. With this Government—as with most coalitions—those who shout loudest get the most. Ask the Trades Unions. At this late hour, Cornwall appears to be getting thoroughly alarmed; the different interests only indirectly concerned are talking of concerted action, and we hope the Cornish motto of " One and All" will at last be demonstrated as an actual fact. The pity of it is that vigorous action has been delayed until the dismissal of men from the mines has actually taken place through the decision of some of the principal companies to cease work in the bottom levels. Dolcoath, Grenville, and Tincroft have all been forced to reduce their labour forces, and unless there is an eleventh-hour turn of fortune's wheel, the Camborne district will soon be faced with very serious troubles. The pumps are already being withdrawn from the deepest workings at Dolcoath, but it is to be hoped that the management will be so able to arrange matters as not to be forced to allow the water to rise beyond the point at which the projected exploratory cross-cut at the 338 fathom level should be driven into the Northern Roskear area, and that the company will find some group with the necessary courage and faith to finance this most promising speculation. But the wealthy local men must back their faith and not expect outsiders wholly to " carry the baby."

MINISTRY OF MINES BILL.—This Bill has at last seen the light of day, but we have yet to hear of anyone whose opinion counts—either from the employers' or workers' side, whether associated with coal or metalliferous mines—who is prepared to give it his blessing, and to say that it is a well-thought-out and statesmanlike measure. The trouble is that with such a docile majority behind them, consisting so largely of members who are not prepared to carry their opposition so far as to vote against a Government measure, the Government will probably get it through the House without serious amendment. The most promising hope of its withdrawal lies in the opposition of the Miners' Unions; whoever thought to have to express thankfulness for support from the Miners' Federation! However, we are not so much concerned with the scheme as it relates to coal mining; we desire to examine it from the point of view of the non-ferrous mines. As we anticipated in the last issue, scant regard is paid to the interests and needs of the metalliferous mines, and well may Mr. Betterton (the Chairman of the recent Non-Ferrous Mines Commission), on the occasion of the second reading of the Bill, have expressed disappointment that this important industry had not received the consideration to which it was properly and justly entitled. It must be quite obvious now to all that the appointment of the commission of inquiry was merely the usual attempt on the part of the Board of Trade to play for time in the hope that an awkward position would right itself, and that the Government never had the slightest intention of adopting any recommendations that would be made. This Bill is merely camouflage so far as metalliferous mines are concerned; no Mines Department on the lines recommended is to be set up. All the Bill provides is for the transfer to the Minister of Mines of the existing duties and powers of the different departments relating to metalliferous mines and quarries, and even this is subsequently qualified so as to allow the Minister to make arrangements for the exercise by such other Government Departments of any such powers and duties as appear could be more conveniently exercised by them. What a farce it all is! And yet it is claimed that the purpose of the Bill is to secure " the most effective development and utilization of the mineral resources of the United Kingdom."

Clause 4 of the Bill provides that the Minister *shall* appoint a committee for the purpose of giving him advice and assistance on matters connected with his powers and duties under the Act relating to coal and the coal industry, and proceeds to set out the constitution of such committee which must be appointed after consultation with the various interests concerned. In the case, however, of metalliferous mines and quarries, the appointment of such an advisory committee is at the Minister's option; further evidence of the scant consideration given to this side of the mining industry. If the defeat of this Bill cannot be secured, we hope at least that strenuous efforts will be made to secure that the appointment of such an advisory committee shall be made compulsory, and the Cornish Chamber of Mines, and other similar organizations in existence for the purpose of protecting and advancing the interests of non-ferrous mining in this country, should combine and use all their resources to this end. With an advisory committee of practical men, representative of all interests, there would be some hope of securing much needed and long overdue reforms. It is stated on good authority that Mr. W. C. Bridgeman is to be the first Minister of Mines at a salary of £2,000 per annum, and one wonders what qualifications he has for a post of this character. He certainly has no first-hand knowledge of metalliferous mining.

PERSONAL

VICTOR C. ALDERSON is here from Colorado.

W. T. ANDERSON has joined the board of the Anglo-French Exploration Company.

L. G. ATTENBOROUGH is here from Malaya.

L. VENN BROWN has resumed the management of the King Island Scheelite company's properties.

D. V. BURNETT is now consulting engineer to Rezende Mines.

SIR JOHN CADMAN has resigned as professor of mining in Birmingham University. He has been elected a member of the Advisory Council of the Privy Council Committee for Scientific and Industrial Research.

GILBERT H. CADY passed through London last month on his way from Burma to the United States.

STANLEY W. CARPENTER is here from Nigeria.

JOHN C. COLLINGS has left for Rhodesia.

G. F. COWPER has resigned as manager of the Wolfram Mining and Smelting Company's mines in Portugal, after having held this position for ten years, and is at present on holiday in England.

FRANCIS DRAKE is on his way to New South Wales.

AUSTIN EASTWOOD has left for Bagdad.

DR. J. S. FLETT has been appointed Director of the Geological Survey, in succession to Sir Aubrey Strahan.

A. G. GLENISTER is here from the Malay States.

E. M. HAMILTON is here from San Francisco on short holiday.

E. C. HARDER, for many years with the United States Geological Survey, is now with the Aluminium Company of America.

W. PELLEW HARVEY has left for British Columbia.

J. E. HEALEY, manager of the Consolidated Main Reef, is here from Johannesburg. He will be paying a brief visit to the United States.

J. C. HOAL is here from Messina, Transvaal.

A. W. HOOKE is back from Nigeria.

J. M. ILES has left for Nigeria.

ALFRED JAMES has returned from Mexico.

R. H. JOHNSON, of the firm of Laws, Rumbold & Co., is back from South America.

C. E. JORDAN is expected from India.

H. M. KINGSBURY is back from India and has gone to the Mines de Villemagne, France.

H. MORTIMER LAMB has resigned as secretary of the Canadian Mining Institute.

F. C. LORING has left for Toronto. He expects to return in the autumn.

H. R. MACKILLIGAN is back from Tavoy.

E. P. MATHEWSON is at the Anyox copper smelter, British Columbia.

WILLIAM MCNEILL is back from Nigeria.

H. W. MERIVALE has left for Trinidad.

A. W. NEWBERRY has been here on a brief visit from New York.

G. R. NICOLAUS has returned from Nigeria.

H. G. PAYNE has gone to the Balkans.

J. C. PICKERING has opened an office, as consulting engineer, at Avenida Juarez 83, Mexico City.

A. S. ROME has been appointed mine manager for Rezende Mines.

R. A. RUSHA has left for Nigeria.

H. SHARPLEY is returning from Barberton.

G. W. SIMMS is home again from the Sungei Besi mines, Selangor.

A. T. WATSON has left for Peru.

E. H. WATSON has left for Burma.

W. Y. WESTERVELT has moved his office from Madison Avenue to 522, Fifth Avenue, New York.

W. L. WHITE has retired as consulting engineer to the Johannesburg Consolidated Investment Company, and has come to England. J. G. LAWN, who was his predecessor before the war, has resumed the position.

ERNEST WILLIAMS has returned from Brazil.

In the March issue of the Magazine brief mention was made of the appointment of Mr. E. C. ANDREWS as Government Geologist for New South Wales. A Queensland correspondent sends us the following appreciation of Mr. Andrews' record and abilities: Mr. E. C. Andrews, B.A. of Sydney University, the newly appointed Government Geologist to the New South Wales Government, is acknowledged to be, both by his writings and originality, the foremost geologist in Australia. His predecessors in the office, at least since Wilkinson, have been very able men, but their geological functions have been subordinated to administrative work, and the application of geology to the material advantages of the people. Andrews, so far, has been a pure scientist. Soon after his joining the Geological Survey of N.S.W., he began the physiographical study of the eastern side of Australia, and the succession of papers from his pen, since then, have elucidated the geological history of that part of the continent in a brilliant manner. In that work he has, and has had, no peer in Australia. His geological reports for the Survey on the mining fields show an accurate perception of lode structure, and its relationships, and are free from the vague generalities often indulged in by officers of government departments. His opinions are his own, formed from his own observation and ideas. In addition to the Fiji experience mentioned in the Magazine, Andrews has travelled in New Zealand and the United States in pursuit of his geological studies, and he is also a botanist. His papers, read before the Linnean Society of N.S.W., show that, if he had not distinguished himself as a geologist, he would have done so as an original thinker in botanical science. Andrews is still a young man, and in his new position should give a permanent lift to the science of geology in Australia. Those who know him expect him to go far in further revealing to us the geological history of this, perhaps, the oldest of all present land surfaces on the globe.

JAMES HOWLISON died in Abyssinia on April 27.

G. G. S. LINDSEY, the Canadian expert on mining law, died on May 27. A few years ago he compiled new mining laws for the Chinese Government.

E. GIBBON SPILSBURY died in New York on May 28, aged 75. He was a Londoner by birth, and was educated at Louvain and Clausthal. He went to the United States in 1870. During the last year or two his attention was chiefly devoted to iron and manganese enterprises in Brazil.

RAYMOND PAYNE died at Westcliff last month after a long illness, at the early age of 45. He was educated in England, and went when 21 years old to West Australia. Thence he went to Dunedin, New Zealand, to join his brother, F. W. Payne, who was then actively engaged in consulting work during the gold-dredging boom. He went to the United States for his brother to arrange for the building of some dredges, the orders having been given there so as to obtain early delivery. Afterwards he came to London and established an office in association with his brother and the late A. C. Perkins, the firm being known as F. W. Payne & Co. He paid a visit to Ecuador to report on alluvial areas. During recent years he has been known for his work in connection with the design and building of tin-dredges for the Malay States and Siam. There was never a more careful and conscientious engineer.

TRADE PARAGRAPHS

BRUCE PEEBLES & Co., LTD., of Edinburgh, send us their pamphlet No. 21 D, describing their continuous-current dynamos and motors.

THE METROPOLITAN-VICKERS ELECTRICAL CO., LTD., announce the removal of their London office to 4, Central Buildings, Westminster, S.W.1.

THE GENERAL ELECTRIC CO., LTD., of 67 Queen Victoria Street, E.C.4, have issued a pamphlet describing the electrification of the Berthllwyd colliery, South Wales; also a pamphlet on switchboards.

THE STURTEVANT ENGINEERING CO., LTD., of 147 Queen Victoria Street, London, E.C.4, send us their catalogue No. 1,023, describing their high-pressure fans and rotary blowers.

RUSTON & HORNSBY, LTD., of Lincoln, send us a number of new circulars and pamphlets, dealing with centrifugal pumps of several sizes, portable steam engines, road rollers, traction engines, and their cold-starting crude oil engines.

T. COOKE & SONS, LTD., of the Buckingham Works, York, send us their pamphlet No. 519, which gives full details of their system of pneumatic despatch. This method of despatching papers, etc., is extensively used nowadays in factories and other works.

THE OLIVER CONTINUOUS FILTER CO., of New York, announce that they are about to open a London office, under the charge of J. F. Mitchell-Roberts. The address will be announced later. Mr. Roberts is a Freiberg man and a member of the Institution of Mining and Metallurgy. He is a metallurgist of wide experience in North and South America, Corea, etc.

HADFIELDS, LTD., of Sheffield, have a stand in the Machinery in Motion section at the Royal Show, Darlington. This exhibit, in addition to showing one of their crushing machines at work, includes large and small castings and forgings, giving some idea of the scope of their manufacture. A representative machine shown is the "Hecla" disc crusher (Symons' patent). Many years of service on all classes of material have fully proved the usefulness of this machine as a medium for secondary reduction, in obtaining a moderately coarse product. The 24 in. size is capable of taking pieces up to 5 by 4 by 2½ in. and reducing them at the rate of about 15 tons an hour down to ¾ in. ring material. As the machine produces cubical pieces, it outstrips all rivals as the ideal medium for producing "top dressing," as needed for road maintenance. Another interesting feature of the firm's exhibit is a 10 ft. long marine forging. Among a variety of appliances for collieries and mines, the firm show many patented specialities. Of these may be mentioned the Rowbotham self-oiling wheels and axles, which, by reason of the efficiency of the lubricating mechanism and the high grade of steel of which the wheels and axles are made, hold a wide field. Wheels fastened by Hadfields' special "lock-fast" method on axles and loose wheels, including some in patent "Era" manganese steel, are shown, also colliery tubs, both wooden and steel, the "Sylat" prop withdrawer, the Wilde & Petrie tub controller, and a special tub greaser.

THE SULLIVAN MACHINERY COMPANY, of Chicago, have instituted cinematograph expositions of the work of their rock-drills, coal-cutters, etc. Mr. S. B. King, a member of the staff, has this matter in charge and the films are made by the Rothacker Film Manufacturing Co., of Chicago. The films are shown at mining and engineering schools throughout the United States and also at the meetings of technical societies. "Building Mining and Quarrying Machinery at a Yankee Shop" is a three-reel picture. It opens with panoramic views of the Claremont and Chicago works. The audience then visits the interior of the Claremont foundry and sees the pouring of air-compressor castings. The air-compressors, made at both the Claremont and Chicago plants, are followed through the various stages of machining, assembly, erection, and the final testing at full speed and load before shipment. Interesting details include the gigantic planer at Chicago on which twelve angle air compound compressor frames are planed at one operation; the assembling of water valves and of finger valves used in the different compressors; and the steam valve action on one of the company's 2,500 Corliss compound air compressors in which the operation of the Corliss valve gear is clearly shown. The second part of the picture shows how hammer-drills are made. The fact is emphasized that the company's rotators, water drifters, stopers, etc., are not made from castings but from solid billets of steel or from steel bars. The observer is shown the wonderful automatic machinery by which the different parts are milled, shaped, and ground to the exact sizes and close fits needed in this class of machinery. Materials are shown under test in the company's chemical and physical laboratories, and also in the carbonizing and heat-treating department, in which rows of furnaces, flanked by quenching baths of different liquids and at different temperatures give the parts of the drills the necessary hardness and toughness to resist the strain of pounding upon rock. This section of the film is completed by a trip to the company's quarries or proving grounds, where the completed machines are tested for air consumption and drilling speed under actual service conditions. Complete views are shown of the company's drill-sharpening machine and drill heating furnaces for the better care and treatment of the drill steel used in mining. The third part of the film deals with incidents in the life of an ironclad coal-cutter. The picture shows the various stages in the construction and assembly of the company's coal-cutting machine which has been the pioneer in the present economical, rapid, mechanical mining of coal. Detailed views of the completed machine were taken in the open air, but under conditions simulating those in a coal mine.

THE CRYSTAL PALACE EXHIBITION.

After being in the hands of the Government for war purposes for over six years, the Crystal Palace was re-opened to the public early last month. The greater part of the buildings are occupied with official war exhibits, but there are also a number of shows connected with general engineering and with the oil industry. A few notes of the exhibits of special interest to mining engineers are given herewith.

CROSSLEY BROTHERS, LTD., of Openshaw, Manchester, show a variety of oil and gas engines.

BELLISS & MORCOM, LTD., of Birmingham, are represented by heavy oil engines suitable for driving air-compressors and pumps.

EXPLOSIVES TRADES, LTD., of 6, Cavendish Square, London, W.1, exhibit explosives of all sorts, together with fuses and detonators.

SULZER BROTHERS, of 31, Bedford Square, London, W.C.1, show oil-driven engines of the Diesel type, air-compressors coupled direct to oil engines, centrifugal pumps, and ventilating fans.

JOHN & EDWIN WRIGHT, LTD., of Birmingham (London Office, Salisbury House), have a large stand where a great variety of steel and hemp ropes are shown. At the present time this firm is supplying large quantities of steel ropes for oil-drilling purposes.

THE FINNEY PUMP CO., of 20, High Holborn, London, W.C.1, show their pump which was described and illustrated in our issue of March last. In this pump the liquid is not in contact with the piston and cylinder, so that the machine may be used for gritty water or corrosive liquids.

THE MOND NICKEL CO., LTD., of 39, Victoria Street, Westminster, show samples of pure nickel sheets, anodes, wires, rods, and pellets; nickel sulphate crystals and powder for use in nickel-plating and the hydrogenization of oils; nickel ammonium sulphate for electroplating; samples of copper sulphate, and the "Blighty" spraying mixture.

WERF CONRAD, of Haarlem, Holland, have an attractive exhibit in the Oil Section. They show improved Canadian oil-drilling plant, and the rapid water-flush percussion system; steel derricks and rigs; portable exploration drilling plant; swelled, solid, and hollow drilling and fishing rods; under-reamers with two pairs of cutters for dry and water-flush systems; flushing tools and accessories, especially for the rapid percussion system; special casing tools, etc. Among oil-drilling tools as manufactured by them are to be seen the following: a detachable casing spear for drawing 17 in. casing; a flushing swivel of heavy construction, with ball-bearing, for hollow rods of 2 in. internal diameter; under-reamers; fishing and drilling jars; an elevator for lifting hollow rods of 2 in. diameter, together with a piece of hollow rod and coupling; a drilling swivel with ball-bearing; a sand line swivel for ½ in. steel cable; a draw swivel for hoisting solid drilling rods; a key wrench with movable key for 2 in. hollow drilling rods; and five sections of rod ends. In addition there is to be seen a large number of the component parts of the Banka hand prospecting drill, which is manufactured solely by this company.

VICKERS, LIMITED, of Broadway, Westminster, show the following: locomotive crankshaft axles; tyres, drop forgings, and stampings; motor-car pressings; high-grade alloy steel; tubes and bars; various magnets; laminated springs; rustless steel propeller, and a special hardened steel roll; engineers' small tools of every description; concrete brick and tile-making machinery; hand and treadle sewing machines; duralumin, the well-known aircraft light alloy; the Vickers sporting rifles and shot gun barrels; standardized joinery; Rene Bull mechanical toys; boxmaking machines (1 stitching machine, 1 single corner and 1 double corner cutting machines in operation); hydraulic rubbers and hydraulic valves. A number of companies associated with Vickers, Limited, also have representative stands as follow: S. E. Saunders, Ltd., East Cowes, Isle of Wight; one 30 ft. standard Consuta motor-launch. Centrifugal Separators, Ltd., 8, Iddesleigh House, S.W.1; one 12 in. centrifugal separator. Ioco Rubber Proofing Co., Netherton Works, Anniesland, Glasgow; waterproof fabrics and rubber goods. T. Cooke & Sons, Ltd., Buckingham Works, York; optical instruments, astronomical telescopes, levels, etc. British Refrigerating Co., 37, Tothill Street, S.W.1; one No. 0 refrigerating plant. Robt. Boby, Ltd., Bury St. Edmunds; Grain dressing machine, Baker winnower, seed cleaning machine, butter churn, two-high malt mill, new type haymaker, Meura mash filter. Taylor Bros., Leeds; roller steel disc wheels, railway axle. Variable Speed Gear, Ltd., Broadway Court, S.W.1; working models of the Williams-Janney variable speed gear. Petters, Ltd., and Vickers-Petter, Ltd., Yeovil; semi-Diesel crude lio engines, Petter Junior engines.

METAL MARKETS

COPPER.—This market has displayed an easier tone during the past month, prices in this country both of standard and of refined having declined somewhat during the period. One of the causes of this has, of course, been the generally downward tendency in other markets as well as the tight position of finance, which factors have naturally had a depressing effect on this article. Another cause has been the offering in this country, and in America, of re-sale lots of Japanese metal. As will be remembered, a considerable time ago Japan bought electrolytic copper very largely, such purchases being the subject of a considerable amount of conjecture as to the reason. That country used to be an exporter of copper, and the fact that she should have turned round and have become an importer naturally caused some surprise. However, whatever the object of the purchases was, the recent financial difficulties there have been the means of dislodging some of these holdings, so that, after all, this factor in the market has been brought about by one of the causes already referred to, namely, financial tightness. Business in the standard market has been fairly active, but the liquidation of that commodity was the means of depressing the price unduly as compared with refined, with the result that a very wide margin was established between the two. As a result it appears that America has been buying standard with the object of taking it to America to be refined, the large spread between the prices of the two grades making this possible. From time to time a fair business has been done in refined copper with Continental countries, particularly Italy. That country is understood to have still fair stocks of metal, but apparently not in such grades as are required at present. Generally speaking, however, the Continental demand is rather slow to awaken. Meanwhile in this country business with consumers continues to be restricted so far as new copper is concerned. This is chiefly due to the fact that large quantities of scrap metal are available, and it has recently been reported that a large parcel, some 4,000 or 5,000 tons, has been sold by the Government. Reports from America are a little conflicting. From time to time a good demand from domestic consumers is reported, but trade there seems to have been generally hampered by the traffic difficulties, which have caused a slowing down of operations both in refineries and in consumers' plants. The market has been rather firmer lately, however, and about 18¾c. to 19c. is now quoted.

Average price of cash standard copper: June 1920, £88; May 1920, £96. 18s. 1d.; June 1919, £83. 0s. 6d.; May 1919, £77. 16s. 8d.

TIN.—This market has shown a generally fluctuating tendency during the month of June, values on balance having declined. The market has now had an enormous drop from the top figures touched some time ago, but whether the fall has as yet spent itself remains doubtful. A great deal of liquidation has taken place, and it may naturally be assumed that the great bulk, if not all, of the old speculative bull account has now been liquidated. In spite of that, there still seems to be a lack of confidence in the situation, and little enterprise is shown. This is partly attributable to the fact that business doing with the actual consuming trades has been slow. The tinplate works in this country are very active, but it would appear that they must have already covered the greater part of their requirements in tin, and as a consequence have been holding off in the hopes of getting in at lower prices. The general downward tendency in the market naturally encouraged them in this attitude. In addition, an-

DAILY LONDON METAL PRICES: OFFICIAL CLOSING
Copper, Lead, Zinc, and Tin per Long

COPPER

	Standard Cash	Standard (3 mos.)	Electrolytic Ingots	Electrolytic Wire-Bars	Best Selected
	£ s. d. £ s. d.	£ s. d. £ s. d	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
June 10	89 5 0 to 89 10 0	92 10 0 to 92 15 0	105 0 0 to 109 0 0	107 0 0 to 109 0 0	105 0 0 to 106 0 0
11	88 15 0 to 89 0 0	92 0 0 to 92 5 0	104 0 0 to 109 0 0	107 0 0 to 109 0 0	104 0 0 to 105 0 0
14	88 0 0 to 88 5 0	90 10 0 to 90 15 0	103 0 0 to 108 0 0	106 0 0 to 108 0 0	104 0 0 to 105 0 0
15	86 5 0 to 86 10 0	88 15 0 to 89 0 0	102 0 0 to 108 0 0	102 0 0 to 108 0 0	102 0 0 to 104 0 0
16	85 5 0 to 85 10 0	88 0 0 to 88 5 0	100 0 0 to 107 0 0	105 0 0 to 107 0 0	102 0 0 to 104 0 0
17	82 5 0 to 82 10 0	84 15 0 to 85 0 0	98 0 0 to 106 0 0	104 0 0 to 106 0 0	102 0 0 to 104 0 0
18	82 15 0 to 83 0 0	85 5 0 to 85 10 0	97 0 0 to 105 0 0	103 0 0 to 105 0 0	98 0 0 to 100 0 0
21	86 10 0 to 87 0 0	89 10 0 to 89 15 0	97 0 0 to 105 0 0	103 0 0 to 105 0 0	98 0 0 to 100 0 0
22	86 15 0 to 87 0 0	89 15 0 to 90 0 0	99 0 0 to 105 0 0	103 0 0 to 105 0 0	98 0 0 to 100 0 0
23	86 5 0 to 86 10 0	88 15 0 to 89 0 0	100 0 0 to 105 0 0	103 0 0 to 105 0 0	98 0 0 to 100 0 0
24	84 5 0 to 84 15 0	86 10 0 to 87 0 0	99 0 0 to 104 0 0	102 0 0 to 104 0 0	98 0 0 to 100 0 0
25	83 5 0 to 83 10 0	86 0 0 to 86 5 0	99 0 0 to 104 0 0	102 0 0 to 104 0 0	98 0 0 to 100 0 0
28	84 15 0 to 85 0 0	87 5 0 to 87 10 0	99 0 0 to 105 0 0	103 0 0 to 105 0 0	98 0 0 to 100 0 0
29	85 10 0 to 86 0 0	88 0 0 to 88 5 0	99 0 0 to 105 0 0	103 0 0 to 105 0 0	98 0 0 to 100 0 0
30	86 10 0 to 86 15 0	89 0 0 to 89 5 0	99 0 0 to 105 0 0	103 0 0 to 105 0 0	98 0 0 to 100 0 0
July 1	87 0 0 to 87 5 0	89 10 0 to 90 0 0	103 0 0 to 107 0 0	105 10 0 to 107 10 0	98 0 0 to 100 0 0
2	89 15 0 to 90 0 0	91 15 0 to 92 0 0	105 0 0 to 109 0 0	107 0 0 to 109 0 0	102 0 0 to 104 0 0
3	88 5 0 to 88 10 0	90 5 0 to 90 10 0	105 0 0 to 109 0 0	107 0 0 to 109 0 0	102 0 0 to 104 0 0
6	87 0 0 to 87 5 0	89 0 0 to 89 10 0	105 0 0 to 109 0 0	107 0 0 to 109 0 0	102 0 0 to 104 0 0
7	87 5 0 to 87 15 0	89 10 0 to 90 0 0	105 0 0 to 109 0 0	107 0 0 to 109 0 0	102 0 0 to 104 0 0
8	89 10 0 to 89 15 0	91 15 0 to 92 0 0	105 0 0 to 110 0 0	108 0 0 to 109 0 0	102 0 0 to 104 0 0
9	89 15 0 to 90 0 0	92 0 0 to 92 10 0	105 0 0 to 110 0 0	108 0 0 to 110 0 0	103 0 0 to 105 0 0

other factor which has no doubt militated in reducing the amount of business doing with consumers in this country has been the fact that Straits tin on spot has been remarkably scarce, and held for high premiums, so that consumers were inclined to postpone buying as long as possible until the situation in that respect would become easier. Some trade has been done with America from time to time, but on the whole the demand from there has been disappointing. No doubt the railway difficulties in America have been largely responsible for this. The supplies of tin continue ample, some very large quantities of Banka metal having arrived here from Batavia via Holland. The lower level of values which has been ruling recently for silver has also been instrumental in bringing out further offering of Chinese holdings of tin. There have been rumours of attempts being made in Batavia and the Straits Settlements to stabilize prices by some form of agreement, but not very much importance is attached to these reports, partly because they are only rumours so far, and in any case it is doubted whether such an arrangement could be for the ultimate good of the market. It is believed in usually well-informed quarters that there are still fair supplies waiting to be marketed, in the Straits Settlements, Batavia, and China, and in the absence of any good demand for the metal the situation is not regarded too confidently.

Average price of cash standard tin: June 1920, £250. 18s. 6d.; May 1920, £295. 3s. 7d.; June 1919, £238. 8s. 1d.; May 1919, £234. 9s. 5d.

LEAD.—This market, like others, has seen a further decline due to the continued liquidation of holdings on the Metal Exchange. The strike trouble at Broken Hill still continues, and from a statistical point of view the market might be regarded as sound, and higher prices probable, but finance has had more influence, holdings have been dislodged, and speculative confidence has been much impaired. As a matter of fact, in spite of much talk some time ago of probable scarcity, up to the present there have been ample supplies. It has to be remembered that the demand from consuming trades and for export has not been brisk, and the supplies now in sight should be sufficient to do for a good long time. Parcels continue to arrive out of stock in Australia, and arrivals have also come in from Spain. Meanwhile the American market has fallen, possibly because there has been talk from time to time of the possibility of shipments of lead from here to the United States. What America would want, however, would be lead of her own domestic production so as to save having to pay the duty on lead of foreign origin, and owing to the difficulty of conforming to all the requirements of the American Customs it seems as if not much business was likely to result in this direction.

Average price of lead: June 1920, £35. 1s. 4d.; May 1920, £39. 3s. 2d.; June 1919, £22. 12s. 2d.; May 1919, £23. 18s. 6d.

SPELTER.—Business in this article with the consuming trades in this country has continued to be disappointing, and the continued liquidation of holdings on the Metal Exchange has been the means of further depressing values. This is the natural outcome of the big speculative movement which took place some months ago, when large quantities were purchased. The demand from actual consumers has been insufficient to absorb these as quickly as they came in, with the result that it is believed that there is now in this country, or to arrive, a very considerable accumulation of metal, perhaps sufficient to keep the consuming trades going until nearly the end of the year. It would appear that many galvanizers had covered their requirements according to the work they booked, and as they find they are unable to turn out the finished article as quickly as they expected, partly owing to the congestion consequent upon railway delays, they now find themselves covered further ahead than they had believed. Prices here have consequently dropped, indeed have come down below the cost of production in most producing countries, but for the reason stated it looks as if this country would not need to buy much more metal for import for some considerable time, and therefore the fact that the metal could not be produced at the price passes unnoticed. Meanwhile the American market has been fairly well held, possibly for the reason that producers see little object in materially cutting the price when there is no demand. The business doing in the United States has no doubt been retarded by the railway troubles, and curtailment in production, it is now understood, is being put into effect. There

PRICES ON THE LONDON METAL EXCHANGE.
Tons; Silver per Standard Ounce; Gold per Fine Ounce.

Lead		Zinc (Spelter)	Standard Tin		Silver		Gold	
Soft Foreign	English		Cash	3 mos.	Cash	Forward		
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.			s. d.	June
35 15 0 to 37 10 0	38 10 0	42 0 0 to 44 0 0	235 10 0 to 236 0 0	241 0 0 to 242 0 0	$48\frac{3}{8}$	$48\frac{1}{2}$	105 3	10
35 10 0 to 37 5 0	39 10 0	41 5 0 to 43 0 0	244 0 0 to 244 10 0	248 10 0 to 249 0 0	$51\frac{1}{4}$	51	104 2	11
35 10 0 to 37 5 0	38 10 0	41 15 0 to 43 15 0	245 15 0 to 246 5 0	249 10 0 to 250 0 0	$44\frac{1}{4}$	$44\frac{1}{2}$	104 4	14
34 15 0 to 36 15 0	37 10 0	41 10 0 to 43 5 0	235 0 0 to 236 0 0	239 0 0 to 239 10 0	44	$44\frac{1}{4}$	104 4	15
32 0 0 to 33 10 0	35 0 0	40 15 0 to 42 5 0	239 0 0 to 239 10 0	242 0 0 to 242 10 0	$44\frac{3}{8}$	$44\frac{3}{8}$	104 2	16
31 10 0 to 33 0 0	35 0 0	39 10 0 to 41 5 0	240 0 0 to 240 10 0	243 0 0 to 243 10 0	$49\frac{1}{8}$	$49\frac{1}{8}$	103 6	17
31 15 0 to 33 5 0	35 0 0	38 5 0 to 40 0 0	245 0 0 to 245 10 0	249 0 0 to 249 10 0	$49\frac{1}{8}$	$48\frac{3}{4}$	103 2	18
32 15 0 to 34 10 0	36 0 0	41 0 0 to 42 15 0	256 0 0 to 256 10 0	259 0 0 to 259 10 0	$51\frac{1}{2}$	$51\frac{1}{4}$	103 4	21
33 5 0 to 34 15 0	36 0 0	40 15 0 to 42 10 0	261 0 0 to 262 0 0	265 0 0 to 265 10 0	$52\frac{1}{2}$	$51\frac{1}{2}$	103 4	22
32 15 0 to 34 0 0	35 10 0	40 10 0 to 42 5 0	256 10 0 to 257 0 0	260 0 0 to 260 10 0	$51\frac{5}{8}$	$50\frac{5}{8}$	103 6	23
32 5 0 to 33 10 0	35 0 0	39 15 0 to 40 10 0	247 10 0 to 248 0 0	250 10 0 to 251 0 0	$50\frac{1}{4}$	$49\frac{5}{8}$	104 0	24
31 0 0 to 32 10 0	34 0 0	39 5 0 to 41 5 0	245 0 0 to 245 10 0	247 15 0 to 248 5 0	$50\frac{1}{4}$	$49\frac{5}{8}$	103 7	25
32 0 0 to 33 5 0	34 10 0	38 15 0 to 40 15 0	244 15 0 to 245 0 0	246 15 0 to 247 5 0	53	$52\frac{1}{8}$	103 7	28
32 5 0 to 33 10 0	34 10 0	39 10 0 to 41 10 0	246 5 0 to 246 15 0	250 5 0 to 250 10 0	$52\frac{1}{2}$	$51\frac{5}{8}$	104 0	29
33 0 0 to 34 5 0	35 0 0	40 10 0 to 42 10 0	246 0 0 to 246 10 0	251 0 0 to 251 10 0	52	$50\frac{3}{4}$	104 0	30
								July
34 5 0 to 35 0 0	36 0 0	41 10 0 to 43 5 0	249 10 0 to 250 0 0	254 0 0 to 255 0 0	—	—	—	1
35 5 0 to 35 15 0	37 0 0	43 15 0 to 45 5 0	260 0 0 to 260 10 0	264 0 0 to 264 10 0	$51\frac{1}{8}$	50	104 0	2
34 10 0 to 35 10 0	36 10 0	44 0 0 to 45 5 0	250 10 0 to 250 15 0	256 0 0 to 257 0 0	52	51	104 0	3
34 5 0 to 35 5 0	36 10 0	42 10 0 to 43 15 0	246 5 0 to 246 10 0	253 10 0 to 254 0 0	$51\frac{1}{2}$	$50\frac{3}{4}$	104 1	6
33 5 0 to 34 10 0	35 10 0	41 15 0 to 43 0 0	247 10 0 to 248 0 0	255 0 0 to 255 10 0	$52\frac{1}{2}$	$51\frac{3}{4}$	104 1	7
33 5 0 to 34 15 0	35 10 0	41 15 0 to 43 5 0	249 0 0 to 249 10 0	256 10 0 to 257 0 0	54	$52\frac{7}{8}$	104 1	8
33 15 0 to 35 10 0	36 0 0	42 0 0 to 43 10 0	258 10 0 to 259 0 0	263 10 0 to 264 0 0	$52\frac{1}{4}$	$51\frac{1}{8}$	104 1	9

must, however, be a fair accumulation of spelter which still remains to find a market. Meanwhile there are signs that supplies may be available for this country on the Continent, it being understood that there are fair quantities of German metal in Holland, and other countries, awaiting re-sale. Norwegian producers have held pretty firmly for their prices, and as a consequence have not been doing much business, so that supplies may also have accumulated there.

Average price of spelter: June 1920, £42. 2s. 11d.; May 1920, £46. 0s. 9d; June 1919, £36. 19s. 6d.; May 1919, £35. 13s. 9d.

ZINC DUST.—Australian high-grade material remains at £85 per ton.

ANTIMONY.—English regulus, as mentioned in our last report, was reduced early in June to £60 per ton, at which figure it has remained. Foreign regulus has been easy, and business has been done down to £48, but warehouse material seems to be now rather better held, and is quoted at about £52.

ARSENIC.—The demand is only small, but prices are firm at £74 to £75 per ton for white delivered London.

BISMUTH.—A steady business continues at about 12s. 6d. per lb.

CADMIUM.—A fairly good demand is about, and a steady business is passing at about 6s. 3d. to 6s. 6d. per lb.

ALUMINIUM.—The home trade price is still quoted at £165, while £185 is asked for export.

NICKEL.—Steady and unchanged at £230 for home and export.

COBALT METAL.—14s. per lb.

COBALT OXIDE.—10s. per lb. (black).

PLATINUM.—There is little feature in this market, and the tone has again been weaker, in view of the continued absence of demand. The price is nominally £20 per oz.

PALLADIUM.—Nominal.

QUICKSILVER.—This market has had rather an uncertain tone owing to the reappearance of second-hand offerings, which in the present quiet state of the demand had perhaps a disproportionate effect in depressing values. The present quotation is about £20 to £20. 10s. per bottle.

SELENIUM.—10s. 6d. to 13s. per lb.

TELLURIUM.—90s. to 95s. per lb.

SULPHATE OF COPPER.—The demand continues quiet. Prompt material is quoted at £44 to £45, while for forward £50 is wanted.

MANGANESE ORES.—This market has ruled slightly easier, although there has been little change in conditions generally. Indian grades are quoted at about 4s. 3d. per unit c.i.f. Several shipments of Caucasian ore have been made recently to this country as well as to the Continent. The price of this grade is about 4s. c.i.f. European ports.

TUNGSTEN ORES.—The tone is easier and business is not very brisk. Business has been reported around 27s. 6d. to 28s. per unit for 65%.

MOLYBDENITE.—Quiet and quotations nominal.

SILVER.—On June 1 the price of spot standard bars was $57\frac{5}{8}$d., falling to 44d. on the 15th of the month. Later the tone became firmer, and at the end of the month the price was 52d. for spot standard bars.

GRAPHITE.—A fair inquiry is about, but the position is little changed, and prices range from £60 to £80 for soft velvety flake, 85% to 90%, to £25 c.i.f. for Madagascar 82% to 85%.

CHROME ORES.—48% to 50%, £9 to £9. 10s. per ton.

IRON AND STEEL.—Business in pig iron has continued difficult owing to the continued scarcity of supplies in comparison to the extent of the demand, and, owing to the pressure of home needs, export business has been rendered practically impossible. Some of the Cleveland works have been able to start idle furnaces, so the quantities available should soon be increased to some extent. Prices remain at 230s. for No. 1 Cleveland and 217s. 6d. for No. 3. East Coast hematite is also scarce, although the situation is not perhaps so stringent as in the case of Cleveland pig iron. The price of East Coast mixed numbers remains at 260s. for the home trade and 265s. for export to allied countries. In regard to manufactured iron and steel, owing to the well booked condition of works, prices are still high and orders difficult to place. There is now an increasing feeling, however, that prices are at the top, and buyers therefore are only inclined to place orders for absolute necessities. Consequently some falling off has been seen in the demand.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Par Value
	Oz.	Oz.	Oz.	£
March, 1919	694,825	17,554	712,379	3,025,992
April	676,702	18,242	694,944	2,951,936
May	706,158	18,837	724,995	3,079,583
June	682,603	19,776	702,379	2,983,515
July	705,523	19,974	725,497	3,081,713
August	686,717	19,952	706,669	3,001,739
September	680,359	18,199	698,558	2,967,287
October	705,313	18,409	723,722	3,074,174
November	657,845	20,125	677,920	2,879,834
December	631,833	18,358	650,191	2,761,836
Year 1919	8,111,271	218,820	8,330,091	35,383,974
January 1920	653,295	17,208	670,503	*
February	607,918	17,412	625,330	*
March	689,645	17,391	707,036	*
April	667,926	19,053	686,979	*
May	681,551	17,490	699,041	*

* Not given in the official returns.

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
April 30, 1919	175,267	11,906	5,742	192,915
May 31	173,376	12,232	5,939	191,547
June 30	172,505	12,544	5,831	190,880
July 31	173,613	12,453	5,736	191,802
August 31	170,844	12,450	5,655	188,949
September 30	169,120	12,392	5,294	186,806
October 31	167,499	12,691	4,492	184,682
November 30	164,671	12,565	4,337	181,573
December 31	166,155	12,750	4,271	183,176
January 31, 1920	176,390	12,766	4,796	193,952
February 29	185,185	12,708	5,217	203,110
March 31	188,564	12,788	5,232	206,584
April 30	189,446	12,951	5,057	207,454
May 31	184,722	12,897	4,793	202,412

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 65% of the working profit. Figures for yield and profit for 1919 based on par value of gold; subsequently gold premium included.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
April, 1919	1,993,652	28 7	22 9	5 9	573,143
May	2,099,450	28 4	22 3	5 10	608,715
June	2,032,169	28 4	22 4	5 10	592,361
July	2,134,668	27 10	21 9	6 0	611,118
August	2,036,128	28 5	22 11	5 5	551,203
September	2,019,109	28 6	22 10	5 7	560,979
October	2,108,698	28 3	22 6	5 10	612,841
November	1,933,526	28 8	23 5	5 5	521,472
December	1,845,088	28 8	25 6	3 10	354,098
Year 1919	24,043,638	28 7	22 11	5 6	6,605,509
January, 1920	2,038,092	34 4	24 2	10 2	1,036,859
February	1,869,180	35 1	28 3*	6 10*	644,571*
March	2,188,104	31 8	25 2	6 6	716,610
April	2,065,446	31 5	26 3	5 2	533,940

* Results affected by the back-pay disbursed in accordance with new wages agreement.

Production of Gold in Rhodesia and West Africa.

	Rhodesia. 1919	Rhodesia. 1920	West Africa. 1919	West Africa. 1920
	£	oz.	£	
January	211,917	43,428	104,063	
February	220,885	44,237	112,616	
March	225,808	45,779	112,543	
April	213,160	47,000	109,570	
May	218,057	46,266	100,827	No official returns published.
June	214,215	—	106,612	
July	214,919	—	102,467	
August	207,339	—	103,112	
September	223,719	—	100,401	
October	204,184	—	91,352	
November	186,462	—	98,322	
December	158,835	—	[illegible]	
Total	2,499,498	226,710	1,240,691	

Transvaal Gold Outputs.

	April. Treated	April. Yield	May Treated	May Yield
	Tons	Oz.	Tons	Oz.
Aurora West	12,800	£14,796	10,240	£13,081
Brakpan	38,500	£74,146	47,200	£82,887
City & Suburban	—	—	—	—
City Deep	60,000	25,012	78,400	30,006
Cons. Langlaagte	43,700	£66,649	44,800	£66,848
Cons. Main Reef	47,200	16,870	50,100	17,875
Crown Mines	182,000	54,879	189,000	58,188
Durban Roodepoort Deep	20,000	6,362	21,700	6,928
East Rand P.M.	128,000	34,196	124,000	34,703
Ferreira Deep	32,900	11,224	32,000	10,767
Geduld	42,000	14,909	43,500	15,417
Geldenhuis Deep	44,400	12,856	44,200	13,042
Glynn's Lydenburg	3,555	£6,937	3,680	£6,931
Goch	18,800	£16,024	16,500	£16,492
Government G.M. Areas	125,000	£251,468	122,500	£257,384
Heriot	10,700	2,791	—	—
Jupiter	23,000	10,392	23,100	5,648
Kleinfontein	50,440	14,297	45,560	13,341
Knights Central	24,400	7,623	25,100	7,576
Knights Deep	85,900	16,526	96,100	17,904
Langlaagte Estate	39,000	£60,142	42,000	£65,331
Luipaard's Vlei	20,110	£25,929	19,585	£26,719
Meyer & Charlton	13,000	£40,284	14,200	£44,410
Modderfontein	86,000	44,562	86,000	44,121
Modderfontein B	50,000	23,393	50,200	24,235
Modderfontein Deep	41,100	21,758	40,800	21,689
Modderfontein East	10,600	£14,828	18,500	£11,835
New Unified			10,300	£14,770
Nourse	38,500	13,534	42,500	14,006
Primrose	19,100	£20,200	20,000	£21,592
Princess Estate	19,200	4,909	19,000	4,640
Randfontein Central	130,000	£163,475	148,000	£176,696
Robinson	40,100	9,520	40,300	9,461
Robinson Deep	51,200	18,180	52,500	16,662
Roodepoort United	20,800	£21,285	24,000	£25,293
Rose Deep	55,800	14,981	55,800	14,719
Simmer & Jack	55,500	12,359	56,800	14,613
Simmer Deep	47,400	10,392	50,500	11,304
Springs	39,600	£76,916	38,000	75,952
Sub Nigel	10,100	5,705	10,300	6,285
Transvaal G.M. Estates	16,760	£27,399	16,650	£29,703
Van Ryn	38,000	£43,471	37,750	£42,271
Van Ryn Deep	46,100	£127,183	46,500	£132,492
Village Deep	46,300	14,393	47,900	15,369
Village Main Reef	16,400	4,833	15,700	5,086
West Rand Consolidated	33,300	£43,342	33,450	£45,713
Witwatersrand (Knights)	37,250	£51,168	37,500	£54,939
Witwatersrand Deep	34,200	8,926	32,000	7,547
Wolhuter	39,000	8,668	32,500	8,624

West African Gold Outputs.

	April. Treated	April. Value	May. Treated	May. Value
	Tons	Oz.	Tons	Oz.
Abbontiakoon	8,070	£16,243	8,543	£15,146
Abosso	6,880	2,355	6,120	2,449
Akoko	—	—	—	—
Ashanti Goldfields	5,101	5,227	5,900	6,337
Obbuassi	542	543	660	854
Prestea Block A	9,676	£17,115	9,214	£13,942
Taquah	4,700	2,813	4,050	2,495

Rhodesian Gold Outputs.

	April. Treated	April. Value	May. Treated	May. Value
	Tons	£	Tons	£
Falcon	14,376	25,580*	12,230	20,410*
Gaika	3,403	5,536	3,357	5,368
Globe & Phœnix	5,734	8,890†	5,565	8,790†
London & Rhodesian	2,650	2,758	2,630	2,832
Lonely Reef	4,850	5,422†	4,650	5,209†
Rezende	5,500	2,324†	5,500	2,535†
Rhodesia, Ltd.	628	387	605	240
Rhodesia, G.M. & I.	—	—	604	430
Shamva	53,288	41,576	55,150	41,770
Transvaal & Rhodesian	1,600	3,750	1,600	4,575

* Gold, Silver and Copper; † Ounces Gold.

West Australian Gold Statistics.—Par Values.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
May, 1919	525	68,655	69,180	293,856
June	1,050	73,546	74,596	316,862
July	680	68,028	68,708	292,852
August	835	58,117	58,952	250,410
September	†	†	†	†
October	586	64,987	65,573	278,535
November	1,171	64,823	65,994	280,323
December	831	27,334	28,165	162,575
January, 1920	836	25,670	26,506	112,590
February	1,928	49,453	51,381	218,251
March	*nil*	54,020	54,020	229,461
April	835	56,256	57,091	242,506
May	227	50,976	51,203	217,495
June	502	56,679	57,181	242,638

† Figures not received.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1919	1920	1919	1920	1919	1920
	£	Oz.	£	Oz.	£	£
January	36,238	7,105	37,100	4,724	18,000	28,000
February	46,955	8,677	43,330	7,200	24,000	15,000
March	40,267	24,126	48,000	6,973	16,000	22,000
April	63,818	—	61,200	8,400	24,000	12,000
May	37,456	—	38,200	8,400	16,000	13,930
June	41,465	—	44,600	—	17,000	—
July	37,395	—	42,060	—	22,000	—
August	51,564	—	49,700	—	20,000	—
September	76,340	—	37,120	—	13,000	—
October	39,018	—	36,100	—	28,000	—
November	40,735	—	32,720	—	51,000	—
December	63,311	—	44,500	—	31,000	—
Total	575,260	39,908	514,630	35,697	280,000	90,930

Australasian Gold Outputs.

	April.		May.	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Associated	5,201	7,687	5,819	6,003
Blackwater	2,248	3,717	2,180	3,716
Bullfinch	3,110	4,484	4,730	5,200
Golden Horseshoe	11,808	23,444	11,832	5,360‡
Great Boulder Prop.	9,181	26,553	7,680	23,026
Ivanhoe	13,081	4,726‡	14,148	4,467‡
Kalgurli	2,963	4,735	4,969	8,641
Lake View & Star	8,704	10,473	10,035	10,945
Menzies Consolidated	1,440	2,954	1,670	3,189
Oroya Links	1,595	8,700†	1,727	10,045†
Progress	1,060	1,245	1,130	1,228
Sons of Gwalia	6,726	8,747	12,478	16,423
South Kalgurli	7,014	6,352	7,590	3,721‡
Waihi	4,547	865‡	12,681	4,025‡
Waihi Grand Junction	8,400A	2,526‡	—	—

† Total receipts; ‡ Oz.; A Six weeks.

Miscellaneous Gold Outputs.—Par Values.

	April.		May.	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
El Oro (Mexico)	29,750	213,000†	30,750	224,000†
Esperanza (Mexico)	23,022	560§	22,862	145‡
Frontino & Bolivia (C'lbia)	2,250	8,813	2,500	9,433
Mexico El Oro (Mexico)	11,208	180,370†	11,300	173,690†
Oriental Cons. (Korea)	21,153	101,607†	—	95,500†
Ouro Preto (Brazil)	7,400	2,742	8,100	2,569‖
Plymouth Cons. (Calif'rnia)	7,600	10,845	7,200	10,099
St. John del Rey (Brazil)	—	33,000	—	37,000
Santa Gertrudis (Mexico)	27,260	30,205‡	26,745	20,192‡

§ Loss. † Dollars. ‡ Profit, gold and silver. ‖ Oz.

Production of Gold in India.

	1916	1917	1918	1919	1920
	oz.	oz.	oz.	oz.	oz.
January	45,214	44,718	41,420	38,184	39,073
February	43,121	42,566	40,787	36,834	38,872
March	43,702	44,617	41,719	38,317	38,760
April	44,797	43,726	41,504	38,248	37,307
May	45,055	42,901	40,889	38,608	38,191
June	44,842	42,924	41,264	38,359	37,864
July	45,146	42,273	40,229	38,549	—
August	45,361	42,591	40,496	37,850	—
September	45,255	43,207	40,088	36,813	—
October	45,061	43,041	39,472	37,138	—
November	45,247	42,915	36,984	39,628	—
December	48,276	44,883	40,149	42,643	—
Total	541,077	520,362	485,236	461,171	230,067

Indian Gold Outputs.

	May.		June.	
	Tons Treated	Fine Ounces	Tons Treated	Fine Ounces
Balaghat	3,300	2,605	3,100	2,301
Champion Reef	12,390	6,907	12,088	6,799
Mysore	19,558	13,099	20,143	13,945
North Anantapur	700	1,796	700	966
Nundydroog	8,258	6,156	8,242	6,220
Ooregum	12,800	7,628	12,700	7,633

Base Metal Outputs.

		April.	May.
Arizona Copper	Short tons copper	1,500	1,500
British Broken Hill	Tons lead conc.	—	—
	Tons zinc conc.	—	—
	Tons carbonate ore	—	—
Broken Hill Block 10	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Burma Corp.	Tons refined lead	1,901	1,510
	Oz. refined silver	233,800	189,900
Fremantle Trading	Long tons lead	—	—
Hampden Cloncurry	Tons copper	—	189
North Broken Hill	Tons lead	—	—
	Oz. silver	—	—
Poderosa	Tons copper ore	430	480
Rhodesian Broken Hill	Tons lead	1,286	1,250
Tanganyika	Long tons copper	1,180	1,725
Tolima	Tons silver-lead conc	40	57
Zinc Corp.	Tons zinc conc.	—	—
	Tons lead conc.	—	—

Imports of Ores, Metals, etc., into United Kingdom.

		May.	June
Iron Ore	Tons	710,592	675,179
Manganese Ore	Tons	30,899	38,685
Copper and Iron Pyrites	Tons	68,112	45,032
Copper Ore, Matte, and Precipitate	Tons	2,185	1,761
Copper Metal	Tons	8,152	10,045
Tin Concentrate	Tons	3,485	3,013
Tin Metal	Tons	4,763	3,923
Lead, Pig and Sheet	Tons	14,568	9,343
Zinc (Spelter)	Tons	11,905	8,162
Quicksilver	Lb.	374,677	110,607
Zinc Oxide	Tons	280	180
White Lead	Cwt.	26,975	19,481
Barytes	Cwt.	86,449	41,763
Phosphate	Tons	69 209	57,150
Sulphur	Tons	6,105	385
Borax	Cwt.	—	1,975
Other Boron Compounds	Tons	2,598	1,894
Nitrate of Soda	Cwt.	101,785	478,608
Nitrate of Potash	Cwt.	15,524	26,867
Petroleum:			
Crude	Gallons	43,945	—
Lamp Oils	Gallons	13,369,656	10,186 219
Motor Spirit	Gallons	16,127,343	22,888,841
Lubricating Oils	Gallons	10,214,742	7,854,469
Gas Oil	Gallons	4,530,795	6,535,821
Fuel Oil	Gallons	24,626,289	32,070,055
Total Petroleum	Gallons	68,941,603	79,536,910

Outputs of Tin Mining Companies.
In Tons of Concentrate.

	March Tons	April Tons	May Tons
Nigeria:			
Associated Nigerian	20	20	20
Benue	4¼	4	–
Bisichi	12	12	5
Bongwelli	–	–	–
Dua	3¼	1¾	2
Ex-Lands	30	20	25
Filani	3½	5¼	3
Forum River	9	9	8
Gold Coast Consolidated	3	2½	2¼
Gurum River	18	14	–
Jantar	15	15	8
Jos	14	12½	8½
Kaduna	18	14½	8½
Kaduna Prospectors	10	9	5
Kano	14	9½	4
Kuru	8	12	9
Kwall	7	5	7
Lower Bisichi	6	5¾	5¾
Lucky Chance	2½	1¾	1½
Minna	3	3¾	1¾
Mongu	50	50	35
Naraguta	28	25	25
Naraguta Extended	14	14	14
Nigerian Consolidated	10¾	10	8½
Ninghi	11	7	6
N.N. Bauchi	40	40	40
Offin River	16	27¾	20½
Rayfield	45	50	40
Ropp	56	49	36
Rukuba	6	–	4
South Bukeru	10	10	6
Sybu	1½	1¾	2
Tin Fields	7	6	4
Federated Malay States:			
Chenderiang	73*	–	–
Gopeng	62½	65½	60
Idris Hydraulic	23¾	20¾	26¾
Ipoh	14⅓	14	14
Kamunting	95*	–	–
Kinta	38¾	35¾	41¾
Lahat	32¾	35¾	35¾
Malayan Tin	65½	65½	41½
Pahang	189	215½	215
Rambutan	18	18	15
Sungei Besi	32	29	30
Tekka	41½	39	31
Tekka-Taiping	32½	36	36
Tronoh	54	21	37
Cornwall:			
East Pool	71	63	72½
Geevor	30¾	33	–
Grenville	35	29½	34¾
South Crofty	47½	47½	54
Other Countries:			
Aramayo Francke (Bolivia)	247	191	160
Berenguela (Bolivia)	31	31	32
Briseis (Tasmania)	24	24	25
Deebook (Siam)	20	26½	22
Mawchi (Burma)	120	100	105
Porco (Bolivia)	25	22	14
Renong (Siam)	35¼	50½	40½
Rooiberg Minerals (Transvaal)	60	55	24
Siamese Tin (Siam)	82	63	87½
Tongkah Harbour (Siam)	89	101	88
Zaaiplaats (Transvaal)	22	23	25

† Two months. * Three months.

Nigerian Tin Production.

In long tons of concentrate of unspecified content.
Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1915	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons	Tons
January	417	531	667	678	613	547
February	358	528	646	668	623	477
March	418	547	655	707	606	505
April	444	486	555	584	546	467
May	357	536	509	525	483	365
June	373	510	473	492	484	—
July	455	506	479	545	481	—
August	438	498	551	571	616	—
September	442	535	538	520	561	—
October	511	584	578	491	625	—
November	467	679	621	472	536	—
December	533	654	655	518	511	—
Total	5,213	6,594	6,927	6,771	6,685	2,361

Production of Tin in Federated Malay States.
Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons
January	4,316	3,558	3,149	3,765	4,265
February	3,372	2,755	3,191	2,673	3,014
March	3,696	3,286	2,608	2,819	2,770
April	3,177	3,251	3,308	2,855	2,606
May	3,729	3,413	3,332	3,404	2,741
June	3,435	3,489	2,950	2,873	—
July	3,517	3,253	3,373	3,756	—
August	3,732	3,413	3,259	2,955	—
September	3,636	3,154	3,166	3,161	—
October	3,681	3,436	2,870	3,221	—
November	3,635	3,300	3,131	2,972	—
December	3,945	3,525	3,023	2,413	—
	43,871	39,833	37,370	36,867	15,396

Total Sales of Tin Concentrate at Redruth Ticketings

	Long tons	Value	Average
August 11, 1919	127½	£17,125	£134 6 5
August 25	130½	£18,297	£140 4 3
September 8	115½	£16,588	£143 12 6
September 22	135½	£19,557	£144 6 9
October 8	72	£10,867	£150 18 7
October 20	32	£5,093	£159 3 2
November 3	34½	£5,235	£151 15 0
November 17	39	£6,161	£157 19 9
December 1	38	£5,905	£155 8 3
December 15	29	£5,133	£176 10 0
December 31	14¾	£2,884	£195 10 10
Total and Average, 1919	2,858	£366,569	£128 5 0
January 12, 1920	31	£6,243	£201 8 0
January 26	51¾	£10,574	£204 6 10
February 9	37½	£7,880	£210 2 8
February 23	53¾	£12,120	£225 10 0
March 8	18	£4,038	£224 7 7
March 22	44	£8,286	£188 6 8
April 6	44½	£8.367	£188 0 5
April 19	33½	£6,375	£190 6 0
May 3	61½	£11,641	£1 9 5 9
May 17	44	£6,151	£139 16 0
May 31	10	£1,578	£157 16 0
June 14	24¾	£3,278	£132 9 3
June 28	14½	£1.932	£133 4 10

Details of Redruth Tin Ticketings.

	June 14		June 28	
	Tons Sold	Realized per ton	Tons Sold	Realized per ton
		£ s. d.		£ s. d.
Tincroft Mines.	10	141 17 6	10	136 10 0
Penryn Minerals	14¾	126 1 3	—	—
Pendeen	—	—	4½	126 0 0
Total	24¾		14½	

Stocks of Tin

Reported by A. Strauss & Co. Long Tons.

	May 31,	June 30.
	Tons	Tons
Straits and Australian Spot	528	347
Ditto, Landing and in Transit	75	730
Other Standard, Spot and Landing	3,571	4,882
Straits, Afloat	1,195	900
Australian, Afloat	347	207
Banca, in Holland	860	413
Ditto, Afloat	2,422	800
Billiton, Spot	—	—
Billiton, Afloat	187	—
Straits, Spot in Holland and Hamburg	—	—
Ditto, Afloat to Continent	505	301
Total Afloat for United States	5,755	6,717
Stock in America	5,356	3,586
Total	20,801	18,883

Shipments, Imports, Supply, and Consumption of Tin.

Reported by A. Strauss & Co. Long tons.

	May	June
Shipments from:	Tons	Tons
Straits to U.K.	670	750
Straits to America	3,755	3,210
Straits to Continent	505	301
Straits to Other Places	343	289
Australia to U.K.	250	150
U.K. to America	1,187	1,217
Imports of Bolivian Tin into Europe	1,520	1,993
Supply:		
Straits	4,930	4,261
Australian	250	150
Billiton	238	—
Banca	1,366	914
Standard	835	1,498
Total	7,619	6,823
Consumption:		
U.K. Deliveries	1,826	1,691
Dutch ,,	—	—
American ,,	3,550	6,500
Straits, Banca & Billiton, Continental Ports, etc.	158	550
Total	5,534	8,741

Dividends Declared by Mining Companies.

Date	Company	Par Value of Shares	Amount of Dividend
June 17	Abosso	£1.	1s. 6d. less tax
June 23	Anaconda Copper	$50.	$1
June 19	Apex Mines	10s.	6d.
July 8	Balaghat	Pref. 10s.	10% less tax*
June 17	Cassel Coal	£1.	1s.
June 14	Clydesdale (Transvaal) Collieries	£1.	1s. 6d.
June 23	De Beers Consolidated	Pref. 50s.	10s. less tax
		Def. 50s.	30s. less tax
July 6	Dundee Coal	£1.	1s. 3d.
June 15	Exploring Land and Minerals	5s.	6% less tax
June 16	Ex-Lands Nigeria	2s.	5% tax free
June 10	Frontino and Bolivia	Pref. £1.	1s. less tax
		Ord. £1.	1s. less tax
June 17	Gopeng Consolidated	£1.	9d. less tax
June 25	Henderson's Transvaal Estates	5s.	6% less tax
June 24	Idris Hydraulic Tin	£1.	1s. less tax
June 28	Ivanhoe Gold Corporation	£5.	1s. 6d. less tax
June 23	Johannesburg Consolidated Invest'nt	£1.	2s. + 6d. bonus tax free
June 19	Kamuntin'TinDredging	£1.	1s. on fully paid, 6d. on partly paid; both tax free
June 17	Leeuwpoort (African Farms) Tin	£1.	1s.
June 19	Naraguta Extended Tin	£1.	2s. less tax
June 21	Natal Navigation Collieries	£1.	9d. + 3d. bonus
June 23	Nechi Mines (Colombia)	Ord. 10s.	4s. 6d. less tax
July 7	Ouro Preto	Pref. £1.	1s. less tax
June 17	Rand Mines	5s.	3s.
June 19	Rand Selection Corporation	£1.	2s.
June 22	Rezende	£1.	4s. less tax
June 19	Rooiberg Minerals Development	£1.	1s.
June 28	Ropp Tin	4s.	10% less tax
June 23	Shamva Mines	£1.	1s. 6d. less tax
June 28	Siamese Tin Synd'te.	£1.	1s.
—	South Crofty	5s.	3d. tax free
June 17	Taquah Mining and Exploration	£1.	1s. 6d. less tax
June 18	Tongkah HarbourTin	£1.	2s.
June 30	Zinc Corporation	Pref. £1.	2s. less tax

Erratum.—The dividend on Camp Bird Preference Shares in last month's table should have been given as 3½ not 3¾%. The dividends declared by Transvaal gold-producing companies for the past half-year with previous distributions are tabulated under Review of Mining.

* At the rate of 10% per annum for period from date of allotment to Dec. 31. 1920.

PRICES OF CHEMICALS. July 8.

These quotations are not absolute; they vary according to quantities required and contracts running.

		£	s.	d.
Alum	per ton	20	0	0
Alumina, Sulphate of	,,	16	10	0
Ammonia, Anhydrous	per lb.		2	0
,, 0·880 solution	per ton	37	10	0
,, Carbonate	per lb.			7½
,, Chloride of, grey	per ton	60	0	0
,, ,, ,, pure	per cwt.	5	5	0
,, Nitrate of	per ton	80	0	0
,, Phosphate of	,,	130	0	0
,, Sulphate of	,,	23	10	0
Antimony Sulphide, Golden	per lb.		1	6
Arsenic, White	per ton	70	0	0
Barium Sulphate	,,	12	0	0
Bisulphate of Carbon	,,	60	0	0
Bleaching Powder, 35% Cl.	,,	26	0	0
Borax	,,	41	0	0
Copper, Sulphate of	,,	43	0	0
Cyanide of Sodium, 100%	per lb.			11
Hydrofluoric Acid	,,			7½
Iodine	,,		16	0
Iron, Sulphate of	per ton	4	0	0
Lead, Acetate of, white	,,	88	0	0
,, Nitrate of	,,	66	0	0
,, Oxide of, Litharge	,,	60	0	0
,, White	,,	66	0	0
Lime, Acetate, brown	,,	20	0	0
,, ,, grey 80%	,,	33	0	0
Magnesite, Calcined	,,	25	0	0
Magnesium, Chloride	,,	17	0	0
,, Sulphate	,,	13	0	0
Methylated Spirit 64° Industrial	per gal.		6	6
Phosphoric Acid	per lb.		1	9

		£	s.	d.
Potassium Bichromate	per lb.		2	6
,, Carbonate 85%	per ton	110	0	0
,, Chlorate	per lb.		0	9
,, Chloride 80%	per ton	40	0	0
,, Hydrate (Caustic) 90%	,,	120	0	0
,, Nitrate	,,	66	0	0
,, Permanganate	per lb.		5	0
,, Prussiate, Yellow	,,		2	4
,, Sulphate, 90%	per ton	45	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	57	0	0
,, Arsenate 45%	,,	60	0	0
,, Bicarbonate	,,	8	10	0
,, Bichromate	per lb.		1	11
,, Carbonate (Soda Ash)	per ton	15	0	0
,, ,, (Crystals)	,,	5	10	0
,, Chlorate	per lb.			6
,, Hydrate, 76%	per ton	32	0	0
,, Hyposulphite	,,	30	0	0
,, Nitrate, 95%	,,	24	0	0
,, Phosphate	,,	44	0	0
,, Prussiate	per lb.		1	6
,, Silicate	per ton	10	0	0
,, Sulphate (Salt-cake)	,,	6	0	0
,, ,, (Glauber's Salts)	,,	10	0	0
,, Sulphide	,,	62	0	0
Sulphur, Roll	,,	19	0	0
,, Flowers	,,	19	0	0
Sulphuric Acid, Non-Arsenical, 140°T.	,,	5	0	0
,, ,, ,, 90%	,,	7	5	3
,, ,, ,, 96%	,,	9	7	6
Superphosphate of Lime, 18%	,,	5	0	0
Tartaric Acid	per lb.		4	0
Zinc Chloride	per ton	27	0	0
Zinc Sulphate	,,	23	10	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	July 11 1919 £ s. d.	July 7 1920 £ s. d.
RAND:		
Brakpan	3 12 6	2 10 0
Central Mining (£8)	9 3 9	8 11 3
City & Suburban (£4)	14 0	5 6
City Deep	3 0 0	2 7 0
Consolidated Gold Fields	2 1 3	1 7 6
Consolidated Langlaagte	1 0 6	15 6
Consolidated Main Reef	14 9	11 9
Consolidated Mines Selection (10s.)	1 6 0	1 1 9
Crown Mines (10s.)	2 5 0	2 6 3
Daggafontein	1 6 6	9 3
Durban Roodepoort Deep	9 0	3 9
East Rand Proprietary	7 6	6 6
Ferreira Deep	11 3	7 6
Geduld	2 10 0	1 18 0
Geldenhuis Deep	13 9	5 6
Gov't Gold Mining Areas	5 0 0	4 2 6
Heriot	15 0	5 6
Johannesburg Consolidated	1 9 9	1 8 9
Jupiter	5 3	2 3
Kleinfontein	13 9	6 3
Knight Central	7 0	3 3
Knights Deep	9 9	5 6
Langlaagte Estate	1 1 6	13 6
Meyer & Charlton	5 0 0	4 15 0
Modderfontein (10s.)	26 15 0*	3 10 0
Modderfontein B	8 13 9	6 1 3
Modder Deep (5s.)	7 12 6†	2 5 0
Modder East	—	1 2 6
New State Areas	—	1 6 3
Nourse	15 6	7 9
Rand Mines (5s.)	3 2 6	2 13 3
Rand Selection Corporation	3 17 6	2 10 0
Randfontein Central	14 3	13 9
Robinson (£5)	14 0	8 0
Robinson Deep A (1s.)	18 9	1 0 0
Rose Deep	18 9	16 3
Simmer & Jack	5 6	3 9
Simmer Deep	3 0	6
Springs	2 17 6	1 12 6
Sub-Nigel	1 5 0	14 3
Union Corporation (12s. 6d.)	17 3	17 0
Van Ryn	19 3	16 3
Van Ryn Deep	3 15 0	4 2 6
Village Deep	16 9	9 6
Village Main Reef	14 0	4 6
West Springs	—	13 9
Witwatersrand (Knight's)	1 6 3	13 9
Witwatersrand Deep	13 0	6 3
Wolhuter	4 9	4 0
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	1 1 3	11 3
Transvaal Gold Mining Estates	15 0	10 0
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	23 2 6	20 5 0
Jagersfontein	6 6 3	4 5 0
Premier Deferred (2s. 6d.)	8 0 0	10 15 0
RHODESIA:		
Cam & Motor	6 6	10 6
Chartered British South Africa	1 3 3	17 6
Falcon	14 6	7 3
Gaika	17 3	13 9
Globe & Phœnix (5s.)	1 7 0	17 6
Lonely Reef	2 13 9	3 0 0
Rezende	5 10 0	2 15 0
Shamva	1 18 9	1 15 0
Willoughby's (10s.)	6 9	5 3
WEST AFRICA:		
Abbontiakoon (10s.)	5 3	3 0
Abosso	10 0	12 0
Ashanti (4s.)	1 2 6	17 0
Prestea Block A	6 9	2 9
Taquah	16 0	16 3
WEST AUSTRALIA:		
Associated Gold Mines	4 0	3 0
Associated Northern Blocks	3 9	3 0
Bullfinch	1 9	3 6
Golden Horse-Shoe (£5)	1 12 6	17 6
Great Boulder Proprietary (2s.)	10 0	7 6
Great Fingall (10s).	2 0	2 0
Hampton Properties	-	12 6
Ivanhoe (£5)	1 17 6	1 3 9
Kalgurli	11 6	13 9
Lake View Investment (10s.)	1 0 0	16 0
Sons of Gwalia	6 6	6 0
South Kalgurli (10s.)	5 9	6 9

GOLD, SILVER, *cont.*	July 11 1919 £ s. d.	July 7 1920 £ s. d.
OTHERS IN AUSTRALASIA:		
Blackwater, New Zealand	8 9	8 9
Consolidated G.F. of New Zealand	3 9	3 9
Mount Boppy, New South Wales	1 0	4 3
Progress, New Zealand	1 9	1 9
Talisman, New Zealand	8 9	7 6
Waihi, New Zealand	2 5 0	1 18 9
Waihi Grand Junction, New Z'lnd	12 6	10 0
AMERICA:		
Buena Tierra, Mexico	17 6	10 0
Camp Bird, Colorado	1 5 3	12 6
El Oro, Mexico	1 3 6	10 9
Esperanza, Mexico	16 0	10 6
Frontino & Bolivia, Colombia	9 3	11 3
Le Roi No. 2 (£5), British Columbia	11 3	10 0
Mexico Mines of El Oro, Mexico	7 5 0	5 5 0
Nechi (Pref. 10s.), Colombia	12 6	9 0
Oroville Dredging, Colombia	1 7 9	1 3 0
Plymouth Consolidated, California	1 9 3	18 9
St. John del Rey, Brazil	18 6	17 9
Santa Gertrudis, Mexico	1 10 0	1 2 6
Tomboy, Colorado	16 0	7 6
RUSSIA:		
Lena Goldfields	1 10 0	1 0 0
Orsk Priority	16 3	10 0
INDIA:		
Balaghat (10s.)	9 0	7 6
Champion Reef (2s. 6d.)	4 9	2 6
Mysore (10s.)	2 5 0	14 3
North Anantapur	1 0 0	4 0
Nundydroog (10s.)	18 3	11 3
Ooregum (10s.)	16 0	15 0
COPPER:		
Arizona Copper (5s.), Arizona	2 6 3	2 8 9
Cape Copper (£2), Cape and India.	2 7 6	1 2 6
Esperanza, Spain	5 9	5 0
Hampden Cloncurry, Queensland	1 2 9	13 9
Mason & Barry, Portugal	2 3 9	1 10 0
Messina (5s.), Transvaal	5 0	5 6
Mount Elliott (£5), Queensland	3 0 0	2 0 0
Mount Lyell, Tasmania	1 4 6	1 3 9
Mount Morgan, Queensland	1 5 9	17 6
Mount Oxide, Queensland	5 0	3 9
Namaqua (£2), Cape Province	2 0 0	1 12 6
Rio Tinto (£5), Spain	60 5 0	37 10 0
Russo-Asiatic Consd., Russia	—	10 6
Sissert, Russia	1 6 3	10 0
Spassky, Russia	1 15 0	1 0 0
Tanganyika, Congo and Rhodesia	5 0 0	1 16 3
LEAD-ZINC:		
BROKEN HILL:		
Amalgamated Zinc	1 8 3	1 7 6
British Broken Hill	2 0 0	2 0 0
Broken Hill Proprietary (8s.)	2 3 0	3 2 0
Broken Hill Block 10 (£10)	1 3 9	1 5 0
Broken Hill North	2 6 3	2 10 0
Broken Hill South	2 5 0	2 10 0
Sulphide Corporation (15s.)	1 0 9	16 9
Zinc Corporation (10s.)	1 0 6	19 0
ASIA:		
Burma Corporation	7 18 9	9 15 0
Russian Mining	1 0 0	10 0
RHODESIA:		
Rhodesia Broken Hill (5s.)	13 6	10 6
TIN:		
Aramayo Francke, Bolivia	4 0 0	3 10 0
Bisichi, Nigeria	13 9	12 0
Briseis, Tasmania	5 0	4 3
Dolcoath, Cornwall	11 3	2 9
East Pool (5s.) Cornwall	16 9	9 0
Ex-Lands Nigeria (2s.), Nigeria	3 3	3 3
Geevor (10s.) Cornwall	1 0 6	12 6
Gopeng, Malay	2 2 6	1 17 6
Ipoh Dredging, Malay	1 2 6	16 3
Kamunting, Malaya	2 6 3	2 10 0
Kinta, Malaya	2 11 3	2 7 6
Malayan Tin Dredging, Malay	2 8 9	1 18 9
Mongu (10s.), Nigeria	19 6	17 6
Naraguta, Nigeria	17 6	10 0
N. N. Bauchi, Nigeria (10s.)	7 3	6 0
Pahang Consolidated (5s.), Malay.	16 6	11 0
Rayfield, Nigeria	16 0	9 0
Renong Dredging, Siam	2 6 3	2 0 0
Ropp (4s.), Nigeria	1 1 0	9 3
Siamese Tin, Siam	3 7 6	3 5 0
South Crofty (5s.), Cornwall	16 3	10 6
Tehidy Minerals, Cornwall	1 0 6‡	16 3
Tekka, Malay	4 5 0	1 1 3§
Tekka-Taiping Malay	5 7 6	1 6 3§
Tronoh, Malay	2 7 6	2 0 0

* £4 shares split into 8 of 10s. each. † £1 shares split into 4 of 5s. each. ‡ 15s. paid up. § New shares.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

THE HUME REINFORCED-CONCRETE PIPE.

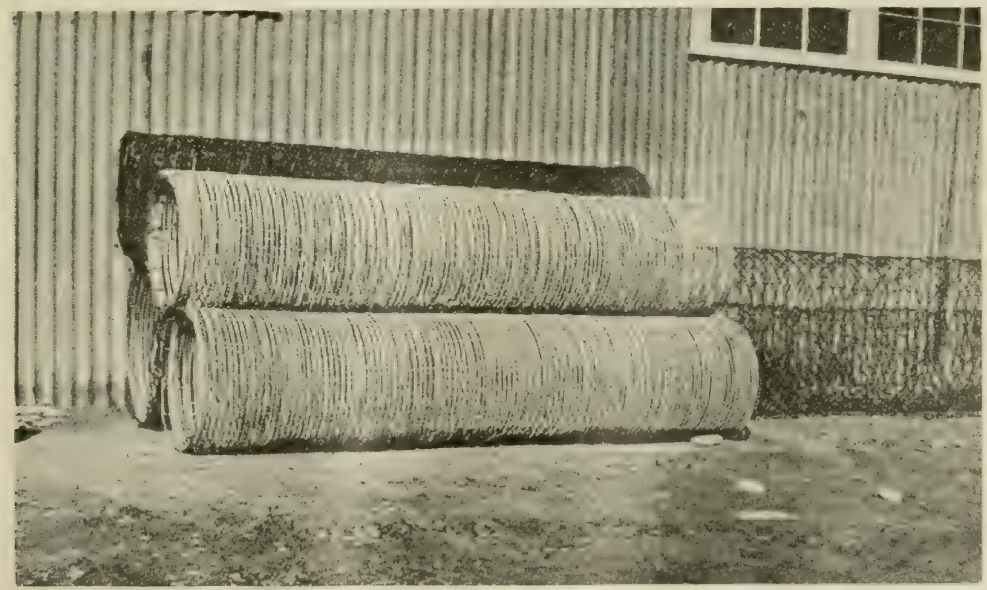
Much has been heard lately of the Hume method of making reinforced concrete pipes. Its manufacture has been introduced in the Transvaal from Australia, and the mining community is keenly interested. The structure of the pipe contains wire wound in circular and also longitudinal shape, and the concrete is placed to shape in rapidly rotating cylindrical moulds. The *Journal* of the South African Institution of Engineers for May contains a description of the pipe and the method of manufacture, written by W. Wolstenholme.

Discarded wire ropes are generally used for the purpose of reinforcement. These ropes must be carefully selected. They are cut into suitable lengths and annealed. The annealing removes the grease and makes the wire ductile, so that it can conveniently be made up into reinforcing cages. The rope is next unstranded, and the individual wires wound on spools and placed on jennies behind the reinforcement weaving machines. These machines are fitted with collapsible drums and the wire is wound on to these drums first spirally and then longitudinally. For high-pressure pipes it may be necessary to have several layers of spiral wire and several layers of longitudinal wires. These layers are pitched automatically so that each falls between the preceding layer. For low pressure pipes it is usual to arrange the wire so that two spiral layers and one set of longitudinal wires are sufficient. When the cage is completed the drum is collapsed and the cage withdrawn. The cage is then placed in the pipe mould.

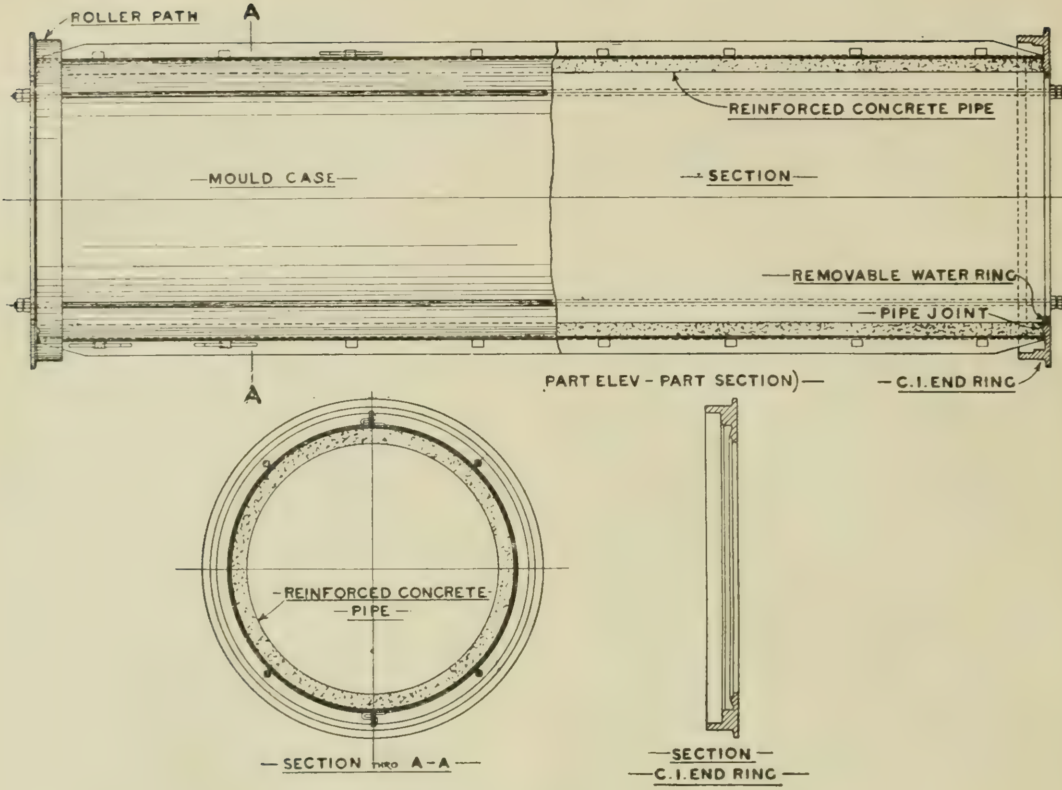
The pipe moulds are usually made of light steel sheet, galvanized preferably, with cast-iron end rings. The end rings serve a treble purpose as they secure the steel casing, form the thickness of the wall of the finished pipe, and provide the running treads which come in frictional contact with the revolving discs of the moulding machine. The moulding machines are of simple design. The frame consists of two longitudinal girders in which are mounted the bearings and shafts. Discs are keyed on the end of each shaft, suitably spaced to receive the end rings of the pipe mould. Variable speeds are obtained by long cone pulleys, by step pulleys, or by variable speed motors. The driving power operates the first disc shaft only, and each succeeding disc shaft is operated by the frictional contact of the pipe mould. On the small moulding machines six pipes, and on the larger machines four pipes, are made at the same time.

The original Australian machines were arranged to make three pipes at one time up to 15 in. diameter, and two pipes at one time in the larger sizes. In re-designing the machines, it was arranged to make six pipes at one time on the small machines, and four pipes at one time on the larger machines.

The pipe moulds are placed in position on the discs, and the moulding machine then commences to revolve slowly. The concrete is thrown into the moulds until the required amount is in. The centrifugal force spreads the concrete evenly through the length of the



WIRE COILS FOR USE IN MAKING THE HUME PIPE.



THE HUME PIPE IN COURSE OF CONSTRUCTION.

mould, and the operator can see when sufficient has been supplied. The machine is then speeded up and the water in the concrete rapidly extracted by centrifugal force. This water accumulates on the inner surface of the pipes and after a short time the machine is stopped, the removable water rings which are fitted into the mould ends are removed, and the water allowed to run out. The machine is again started up and run at high speed and the pipe dried out.

If an exceptionally smooth internal surface is desired, a polishing bar is firmly applied to the surface of the concrete. This bar usually consists of a polished piece of steel pipe and is pressed down on the concrete. Another method of smoothing the surface is by the insertion of a steel cylinder somewhat smaller in outside diameter than the bore of the concrete pipes. Mounted longitudinally on the surface of the cylinder are a series of sheet-iron strips which act as trowels. These trowels come in contact with the concrete and tend to smooth the surface. The cylinder may be revolved in the opposite direction to the pipe or may be stationary.

The time required to complete a batch of pipes varies with the size of the pipe and the quality of concrete used. Generally speaking, six 4 in. or 6 in. diameter pipes can be completed in eight to nine minutes, while four 15 in. or 18 in. diameter pipes require about fifteen minutes. Pipes of 48 in. or 60 in. diameter can be finished in about twenty minutes. Pipes up to 15 in. diameter are usually made in 6 ft. lengths, and 18 in. to 72 in. diameter in 8 ft. lengths. These lengths may be sub-divided into shorter lengths by placing a steel dividing ring in the mould.

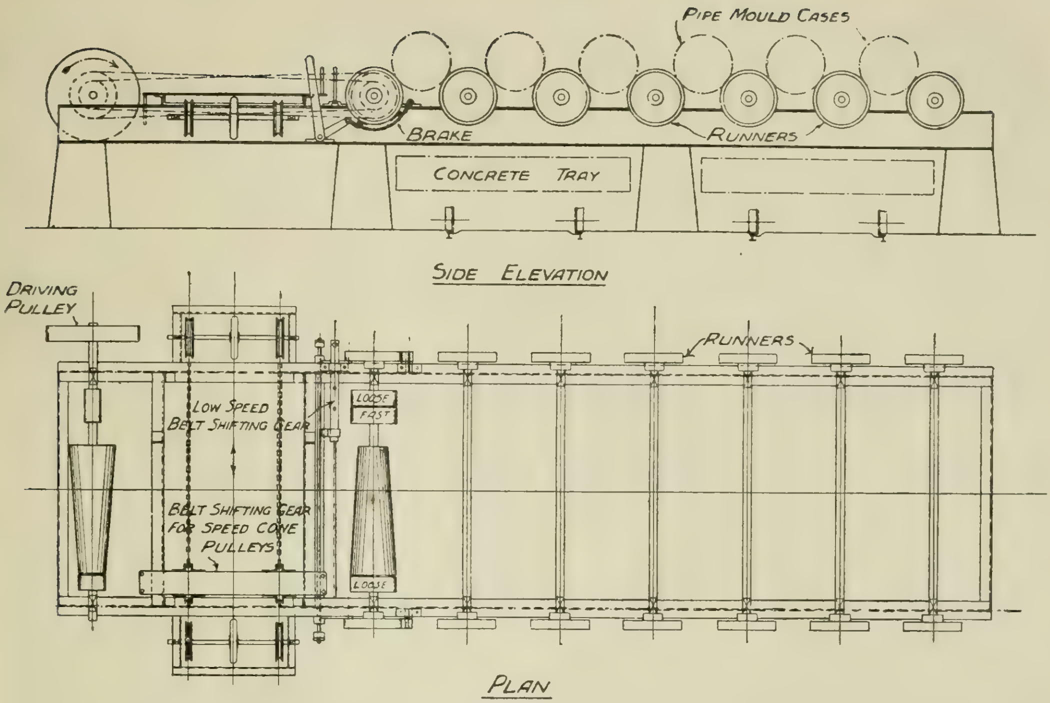
When the pipes are completed on the moulding machine they are carefully rolled into the steaming chamber and left in a temperature of about 200° F. for twelve hours. They are then removed from the moulds and placed overhead in water for at least one week if high-pressure pipes, and for a shorter period if for low-pressure or drainage purposes. The pipes are then stacked for a further period, at least four weeks, before delivery.

Pipe collars are made in exactly the same manner as pipes, excepting that thin steel division or parting plates are placed in the mould at intervals of 6 in. or 9 in.

As already mentioned, steel wire obtained from selected wire ropes is used for the reinforcement. For very high pressure new steel wire of high tensile strength may be used, while for the highest pressures a sheet steel liner is embedded in the concrete. Using the latter method of reinforcement a test pressure of 750 lb. per square inch has been obtained. It is found that for high-pressure pipes a mixture of 2 parts washed and screened sand and 1 part cement gives the best results, while for low-pressure pipes 2 parts of crushed waste rock from the mines, 2 parts sand, and 1 part cement gives good results.

A certain percentage of all pressure pipes are tested regularly. With small diameter pipes, say up to 9 in., the test pressures go up to 300 or 350 lb. per square inch. With large diameters, say, 18 in. and 24 in., tests have been made up to 210 lb. per square inch. These figures are obtained on pipes with reinforcements made from the wire taken from discarded wire ropes.

The reinforcement is carefully calculated and arranged so that at working pressure the wire is never



Details of Machine for making the Hume Pipe.

stressed higher than one-fourth of the elastic limit of the wire used. Generally, a lower stress is taken so as to have ample margin to resist shock loads due to water hammer, etc. The strength of concrete in tension is not taken into account, though as a matter of fact, such strength adds further to the safety of the pipe. In testing the pipes in actual practice under working conditions, it is found that when an excessive overload is applied the pipes sweat heavily and so release the excessive pressure. The pipe may develop slight cracks, but will not burst. Under the worst circumstances the pipes will carry water again when pressure is back to normal, generally without leakage, but in any case they will carry water until such time as defective pipes can be replaced.

The test of an 18 in. diameter pipe made for 100 lb. pressure, showed that at 210 lb. it sweated heavily and it was not possible to raise this pressure. Slight longitudinal cracks were visible under the overload test. At 100 lb. pressure the pipe was tight six months after the overload test was made.

The joints are made in a simple and efficient manner. A collar reinforced in the same manner as the pipe is slipped over the joint. The space between the outside of pipe and inside of collar is rammed up with a mixture of 1 sand and 1 cement. For high-pressure joints, in addition to the ramming, a plastic substance of special mixture is filled into a cavity formed in each pipe end. The pipe ends are tightly butted together, with the plastic material completely filling the cavity. When the pressure is applied inside of the pipe any leakage of water at the joints tends to displace the plastic, and forces it more tightly into position in the cavity and so prevents the leakage reaching the ramming in the collar. The plastic is a special composition and retains its condition for many years.

In addition to the use of concrete pipes for conveying high and low-pressure water, they are sufficiently dense to carry sewage without the least risk. The process had also made it possible to make exceedingly thin pipes. Such pipes have been supplied for carrying air for ventilation purposes underground on the mines. Pipes of 12 in. to 18 in. diameter are regularly made $\frac{1}{4}$ in. to $\frac{3}{8}$ in. thick. These pipes are reinforced with ordinary wire netting of $1\frac{1}{2}$ in. or 2 in. mesh. These pipes are also in use as smoke stacks. Thousands of feet are in use carrying electric cables for post-office telephone service, etc. Special pipes are made for lining bore-holes, wells, etc. Culvert pipes have been supplied in large quantities, and are rapidly replacing the box form built in situ. Tanks for the conservation of rain-water and for the storage of mealies and ensilage are regularly made.

In reply to questions, Mr. Wolstenholme said that he had a great amount of hesitation in subjecting a concrete pipe to the pressure of an elastic fluid like steam or compressed air. If a Hume pipe, or any concrete pipe, happened to receive a blow from an external source—a pick or a boulder—the blow might crack the concrete and loosen a piece, and that piece would be blown out by the compressed air. Also in carrying air they were dealing with something so dry that the concrete the whole time would be undergoing a drying-out process. In the carrying of water, sewage, or steam there would be a certain amount of dampness always present, which would tend to keep the pipe in good condition. For these reasons the makers had not yet offered to supply pipes for air.

SAMPLING AT GREAT COBAR.

The *Proceedings* of the Australian Institute of Mining and Metallurgy, No. 36, 1919, contains a paper by Walter G. A. Smith describing the method of sampling at the copper and gold mines of the Great Cobar company, New South Wales.

The ore-bodies in the Great Cobar copper mine, Cobar gold mine, and Cobar-Chesney copper mine are, speaking generally, lenticular deposits of evidently more or less complete metasomatic replacements of the country-rock along a line of powerful faulting. These lenses vary from 150 ft. to 400 ft. in length, and from 20 ft. to 100 ft. in width.

The ore-bodies at the Great Cobar copper mine are three separate lenses—the north, the middle, and the south—and consist of replacements occupying shear zones and the intervening space between contiguous zones of shearing. The country-rock is slate of Silurian or older age. The middle and south lenses were certainly connected at the surface originally, as doubtless were the middle and northern lenses, prior to the erosion of the original outcrop. The western or foot-wall side is formed by a fault which limits the ore deposition in that direction. East from the foot-wall to the hanging wall, if such it can be called, there is first a small quantity of an intimate mixture of galena and blende, then the primary ore proper, consisting of pyrrhotite mainly, some pyrite, and magnetite carrying chalcopyrite. Following this is an ore, mainly magnetite, but carrying some pyrrhotite and chalcopyrite, and finally silicious ore consisting of altered slate (silicified and carrying magnetite) traversed by bands of quartz, with chalcopyrite and some pyrrhotite, and finally grading into magnetite or silicified slate with quartz seams, but very little chalcopyrite.

The lode in the Cobar gold mine is a silicious ore-body, mainly of replacement quartz, occupying a sheared and faulted zone in rock of similar age to the Great Cobar copper lode, a fold in the bedding of the rock having offered the opportunity for the deposition of the ore. The ore consists principally of quartz, partly replacement quartz, and more or less completely replaced slate, or sandstone, carrying chalcopyrite, and in lesser quantities pyrrhotite, magnetite, pyrite, mispickel, galena, and blende, and some gold and silver.

The occurrence of the lode at the Cobar-Chesney copper mine is similar to that at the Cobar gold mine, except that a considerable quantity of the ore resembles the silicious ore at the Great Cobar copper mine, that is, it is less of a quartzose and more of a slaty nature, and carries but little gold or silver. The folding also is not so appreciable in amount as at the Cobar gold mine, and, whereas at the Cobar gold mine the ore-body is not in the main line of faulting, at the Cobar-Chesney copper mine it is so, or nearly so.

The ore-bodies at the Great Peak gold mines appear to lie along the intersection of shear zones with anticlinal axes; they are very erratic, and are to some extent apparently secondary. The gold and silver occurs in slate, frequently without the usual accompaniment of quartz, though not invariably so, so that material that frequently resembles worthless country-rock carries payable quantities of gold and silver.

The ore-bodies in the copper mines being low-grade, say 2½ to 3% copper, a most rigid and exacting method of close channel-sampling was constantly carried on in order to avoid breaking, or, if breaking was unavoidable, to avoid hoisting unpayable ore. Again, every care was taken to eliminate the chances of foreign matter, such as mullock-filling, getting mixed with the samples while sampling was in progress.

The flat-back system of stoping with filling was worked, and, as the mullock-filling consisted of soft oxidized clay-slate quarried in special excavations west of the lode, it will be readily seen that the inclusion of a small quantity of mullock in a sample might change a payable sample into an unpayable one, in a mine where a plus or minus 0·2% is a consideration.

The sampling gang comprised 12 miners, divided into 6 sets of two men per set, one hammer-man and one steel-man, under the personal supervision of the chief sampler and his assistants. The sampling outfit consisted of a 7 lb. double-hand hammer and ⅝ in. octagon steel cutters with ½ in. chisel points. These cutters are similar to the steel cutters used in narrow lode hand-labour mines for cutting foot-wall hitches. The bar steel was first cut into lengths of 15 to 30 in., the former for face sampling and the latter for back sampling, the moil and pick so often used in other mines being found unsuitable. A sample sheet, 12 by 12 ft., of shot-grained American cloth with a stout duck back, a bannister brush, linen sample bags, sample books, metallic tapes, prismatic compass, field book, and chalk completing the outfit. The sample books employed were of the usual type, each page being perforated and both slip and butt numbered correspondingly. For sampling purposes each level in a mine was given a distinguishing sample letter or letters, the key to which was known only to the general manager, mine manager, and chief sampler. No two mines had the same letter or letters for the same levels. This letter or letters, with the number of the sample, is all that appeared on the sample ticket accompanying the sample to the assay office, the particulars of the sample being entered on the sample-ticket counterpart.

All development work in progress in ore or lode-formation was kept sampled to within 10 ft. of the face and completed after mining operations were finished.

In sampling a cross-cut, the backs are rapped out with the hammers, and all baulky ground and easy stuff, that is, loose ground likely to fall on the sample sheet, is removed; a datum point is established on some permanently fixed and known point, such as a survey peg in the drive or the centre line of the drive; a metallic tape held on the datum point is carried to the face at right angles to the strike of the lode, as disclosed, and in close proximity to the backs; a light, either an acetylene lamp or candle, is placed on the floor vertically under the tape, and the shadow of the tape thrown on the back is traced over with chalk, after which this line is divided into 5 ft. sections; the sample sheet is laid down; the miners, removing their boots to eliminate the chances of vitiating the sample, step on to the sample sheet. One man holds the cutter vertically on the back; the other man strikes it in a manner similar to beating an upper. Thus a narrow, even channel is cut 5 ft. in length, 1½ in. wide, and ½ in. deep. The sample on the sheet is carefully brushed to the centre, tipped into a sample bag, and, with the sample ticket on top, tied in the usual manner.

The procedure in sampling a drive is similar to sampling a cross-cut, except that the sample cuts are marked off 5 ft. equidistant across the backs and at right angles to the strike. A full cut across the backs makes one sample, and is measured at right angles to the dip. In sampling a drive-face two cuts are taken across the face, one a third of the distance down from the back, and one two-thirds down. These two cuts are mixed and constitute one sample, unless a marked change is noticed in the face, when the changes disclosed are sampled separately.

Winzes and rises are sampled by cuts taken 10 ft. apart vertically, and staggered alternately on opposite sides at right angles to the strike of the lode, the datum point in this instance being the rail-level above in the case of the winze, and the rail-level below in the case of a rise, the distance either above or below being referred to it accordingly.

Immediately mullocking operations are completed the sampling of the stope backs is started in advance of the miners, in order to acquire an approximate knowledge of the values likely to be met with prior to breaking. After rapping out and sounding the backs for baulky ground, an examination is made by the chief sampler, and all changes in the ore-body, intrusions, faults, etc., exposed are duly recorded and reported to the mine geologist. A prismatic survey is made from some permanent and known point, such as a rise or permanent country pass, this point being used as the datum point for sampling operations. A diagrammatic sketch of the stope is made in the field book, the strike of the lode established, and a metallic tape held on the datum point is carried to the face parallel to the strike; off-set measurements are taken on this line to all salient points, passes, rises, etc., and their bearings and distances picked up from the datum point. Connection is made through the passes to the level below, and the height of backs above rail-level noted. Particulars of this preliminary work are recorded by the chief sampler in his field book. With an off-setter points are picked up along this line every 10 ft. on the walls of the stope; a metallic tape is held on these points close to the backs, and the tape line shadowed and chalked off, as was done in the case of a cross-cut. The chalk line is then divided into 5 ft. sections across the lode, each 5 ft. section constituting one sample. Thus the backs of a stope are divided into cuts across the back 10 ft. equidistant along the strike, and subdivided into 5 ft. sample sections across the lode. (See Fig. 1). The sample sheet is then laid down and sampling operations are started in exactly the same manner as that employed in sampling a cross-cut. The stope-face samples are taken by one cut across the face divided into 5 ft. sample sections. Sampling operations in a wide stope, say 40 to 100 ft. wide, would be probably carried on with four or five sets of men, in which case at least 20 ft. would divide each set of men while sampling.

It occasionally happens that during the cutting of a sample a small quantity of ore or rock will disintegrate from the walls or back and fall on to the sample sheet, mixing with the sample, in which case the whole is rejected and another sample taken. In sampling both stopes and development work running with the lode, it frequently happens that the face is not truly at right angles to the strike of the lode. In such a case the width of the sample is measured at right angles to the lode, and not along the face. Again, a drive is not always driven parallel with, and a cross-cut is not always at right angles to, the strike of the lode, possibly owing to local contortions changing the strike of the ore-body. Instances of these local contortions were encountered in the silicious ore-body when the mineralized portion of the slates, that is, the lode, was found to be striking in a different direction. In these instances samples were always cut and measured at right angles to the strike of the lode as disclosed at that point. (See Figs. 2 and 3).

The average weight of sample taken is approximately 2 lb. per foot.

The foregoing description shows the method of underground sampling employed in the Great Cobar copper mine, and is analogous to that followed in the other mines of this company, with modifications in the widths and distances apart as circumstances required. Thus:

Mine.	Sample width in ft.	Distance Apart. Ft. Development.	Stoping.
Great Cobar Copper Mine	5	5	10
Cobar-Chesney Copper Mine	3	5	10
Cobar Gold Mine ...	2	5	10
Great Peak Gold Mine ...	1	2	2

In computing values the geometrical mean was used. Where samples are cut equidistant the geometrical mean over the whole area sampled is obtained by multiplying each sample width by its corresponding assay-value obtaining in this case, feet % and feet oz., or, in other words, the units contained in each sample. The sum of these units is then divided by the sum of the widths.

It is generally found that the faces in current sampling are at unequal distances apart, and occasionally that, in stope-back sampling, samples are unobtainable at equal distances apart owing to baulky ground, etc. Therefore, when computing values where samples are

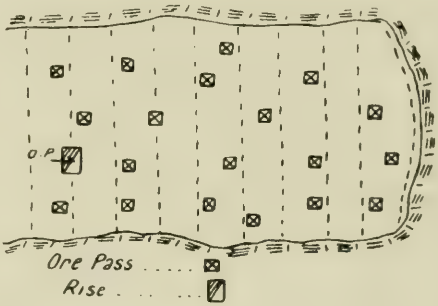


Fig. 1.

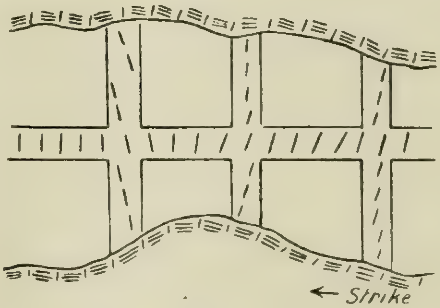


Fig. 2.

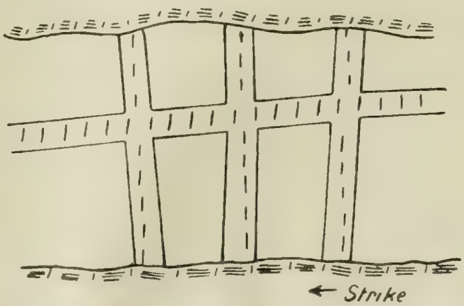


Fig. 3.

cut at unequal distances apart, allowance was made for the variation of the distance between samples by introducing a distance factor. Or, in the case of development face sample, which amounts to the same thing and is easier to calculate, the average value of two faces multiplied by the distance between them can be taken, and this process repeated for all the faces sampled. The sum of the distance values is then divided by the total distance, and the result is the average value of the piece of work sampled.

When estimating ore reserves the ore in situ is divided into two main classes: (1) ore blocked out and (2) probable ore. It was usually found that three exposed sides of a block was ample justification for the term "ore blocked out." These three sides would probably consist of two levels and a winze through the centre of the block. Then the area of the upper level multiplied by its average assay-value, plus the area of the lower level multiplied by its average assay-value, modified by any considerations due to the values of the block as proved by the winze, divided by the sum of the areas, equals the average assay-value of the block. The volume is obtained, if the areas approximate closely to one another, by simply multiplying the mean of the two areas by the height between levels; if, however, the areas differ greatly the tonnages are obtained by the prismoidal formula.

Blocks opened on only two sides are usually termed "probable ore." Under this latter category come also drives on a body of ore which has not been opened at other adjacent levels. In this case 60 ft. (30 ft. above and 30 ft. below the level) is taken as the maximum height of the block.

Ore which may reasonably be assumed to exist below the lowest level is also termed "probable ore," and is (1) either calculated to some arbitrary depth, say 30 ft., or (2) calculated as a pyramid, with the proved shoot area as a base, and a depth equal to one-third of the shoot length.

The ore reserves are estimated annually by the above method for the annual report. Any variations in the calculated widths of one estimate might add to, diminish, or confirm the subsequent estimate. In any case each time they were re-estimated the old balance was written off and the new estimate substituted.

Assay plans were kept by the chief sampler. A plan of the sill floor of each level was taken from the survey plans to a scale of 30 ft. to the inch, and all development work and sill-floor stoping filled as sampling progressed. Sample cuts, widths, and values were shown in various coloured inks, each mineral having a distinctive coloured ink allotted to it. The value of Cu, Au, Ag, Fe, and insolubles, and width of each and every sample taken, could thus be seen at a glance.

Stope-assay plans plotted by the chief sampler from his field-notes were kept for each stope taken off, showing height of backs above rail level, date of starting, and completion of stoping and sampling operations, also values, widths, and location of samples cut. All assay plans were transferred to tracing cloth which allowed the various lifts in a stope to be superimposed at any time, and a comparison of values made. Blue prints were taken off as desired for the information of the mine manager as stoping progressed.

MEASUREMENT OF QUARTZ-DUST BY THE KONIMETER.

In the issue of July, 1918, we gave a description of the konimeter, an apparatus invented by Sir Robert Kotze, Government Mining Engineer for the Union of South Africa, for the purpose of counting the number of dust particles in a given volume of mine-air. One of the criticisms levelled at this instrument was that, though it provided a method of counting the number of particles, it did not differentiate between the harmful quartz and the comparatively innocuous minerals in ore. At the suggestion of the inventor, Dr. A. W. Rogers, chief geologist to the Union Government, investigated the matter from the petrological point of view. His results are given in a paper published in the April number of the *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa. The method devised by Dr. Rogers makes it possible to count the number of quartz particles half a micron wide or larger, separately from those of other minerals found in the dust caught by the konimeter. The counting is done as rapidly as that of the dust particles themselves.

When the contact between a colourless mineral and the surrounding medium is examined under a high power of the microscope, it is more or less clearly visible according to the difference between the refractive indices of the two substances. If the tube of the microscope be raised slightly above the position of correct focus, the side of the contact occupied by the substance with the higher index becomes strongly illuminated, while the other side is darker than the rest of the field of view. When the tube is lowered, the bright light goes to the side occupied by the substance with the lower index. This method of comparing refractive indices is known as the "white line," or Becke's, test, and it is commonly used in petrography, where the size of the grains is usually much greater than that of dust particles. The effect produced is considerably more conspicuous in a dust particle than in the minerals of a thin section of rock, because the particle is small, and the "white line" becomes a spot of light when seen within the area of the particle, and also because the contact between the dust and medium is free from any third substance, which is often not the case with minerals in rock slices.

The phenomena are easily seen in white light when the difference between the indices is 0·002; so that when two minerals differ by 0·004 or more, their immersion in a liquid with refractive index about half-way between those of the minerals makes it possible to count the particles in two classes, those which appear as bright spots with raised tube, and those which appear as bright spots with lowered tube, respectively more and less refractive than the liquid.

The minerals which make up the sedimentary rocks of the Main Reef horizon are known through microscopic examination of thin sections; of the transparent constituents quartz is the most abundant, then come the flaky minerals mica, chlorite, and talc, and the less abundant or occasional minerals are chloritoid, calcite, zircon, and a few others less often seen. Of all these minerals quartz has the lowest mean refractive index. The lowest indices of talc and calcite are lower than the least index of quartz, but the fact does not affect the observations, because the lowest indices of calcite and talc practically never come into play under the conditions of the test, and if they do their effect is masked by that of their higher indices which greatly exceed the highest of quartz.

The refractive indices of the more common minerals in the rocks of the Main Reef horizon are given in the following table; other occasional constituents such as anatase, tourmaline, epidote, all have high indices:

	ω / σ	ε / β	γ
Quartz	1·544	1·553	
Calcite	1·658	1·468	
Zircon	1·931	1·993	
Rutile	2·616	2·903	
	σ	β	γ
Mica	1·563	1·598	1·601
Talc	1·539	1·589	1·589
Chlorite	1·582	1·584	1·59
Chloritoid ...	—	1·74	—

Owing to the fact that the lowest indices of mica and talc have effect only when these minerals are seen edgeway to the cleavage, which, on account of their perfect cleavage, is very rarely the case when the flakes lie in liquid between slide and cover slip, the smallest difference between indices operative in the dust from the sedimentary rocks of the Witwatersrand mines is 0·034, that between the highest of quartz and the mean and highest of talc. Cleavage fragments of calcite have a lowest index of about 1·56, but its effect is entirely over-shadowed by that of the highest index of calcite, which every grain of the mineral must show.

In the konimeter the dust is caught on vaseline, and the immersion liquid must be a solvent of vaseline. Monobromobenzene, with an index of 1·56, and bromoform (1·58) dissolve vaseline, and a mixture of equal volumes of the two has a suitable index for separating the particles of quartz from those of other minerals in the dust; solution of the vaseline film by it does not lower its index too much. The position of the spot on the slide removed from the konimeter should be marked by a ring of ink on the back of the slide; a drop of the liquid is placed on a thin cover slip, which is carefully lowered on to the slide, when the liquid spreads over the spot.

For the microscopic examination an eighth-inch objective and low power eye-piece are a good combination, and they resolve particles down to 0·3 micron wide. A twelfth-inch oil immersion objective will extend the resolvability to 0·2 micron, but the smaller field and additional manipulation counterbalance this advantage over the dry eighth. The observations are best made in parallel light, but should the illumination be insufficient, a convergent cone of low angle will serve.

Having got the dust spot into focus and sufficiently illuminated, the tube of the microscope is raised slightly, when the particles with indices greater than that of the liquid (all transparent minerals other than quartz in the dust from the sedimentary rocks from the mines here) appear bright and can be counted. The tube is then lowered below the focal position, when the previous bright particles become dark and are surrounded by a halo of light, while the less refractive particles (quartz) become bright spots and can be counted. It is easier to count bright spots than dark ones, so it is better to count bright spots first with raised tube and then with lowered tube than to count both bright and dark spots with the tube in one position; but the result of both procedures is the same. Opaque particles are counted with the tube in the focal position. Particles which are below the limit of resolution appear as indefinite spots by diffraction, and they may be confused with either class, for they give light spots with raised or lowered tube, but very little experience is required to recognize them and avoid any error from their presence. Neither the shape nor transparency of these particles can be determined, and one remains in ignorance of their nature. Many of the opaque particles are pyrite, as shown by the colour of the larger ones when examined in reflected light.

If felspars occur in the rock which furnishes the dust, as they do in some of the intrusive rocks in the Rand district, their particles would be counted as quartz by the method described above. In most of the dykes of the Witwatersrand, however, the felspars have been replaced by quartz, mica, and epidote, which cause no difficulty; but if kaolin be present it would behave like quartz. The other minerals in the dykes are chiefly amphiboles and pyroxenes, which are much more refractive than quartz.

In dust from rocks containing the oligoclase andesine and labradorite series of felspars as well as quartz, it is practically impossible to count the felspar particles separately from those of quartz on a large scale; but the alkali felspars, orthoclase, microcline, and albite, can readily be counted separately from quartz in dust from granite by the use of monobromobenzene or bromoform diluted with xylol or benzene, and all these minerals separately from more refractive ones by the mixture used on the dust from the local mines. Owing to the widely differing boiling points of the two groups of liquids, the refractive index of the solution becomes higher by evaporation of xylol or benzene, and this must be guarded against.

The method described here is capable of great refinement by the comparison of the lowest and highest indices of individual grains in polarized light, by which the effect of each index can be isolated and eliminated in turn; though this can be done quickly, its application to the hundreds of particles in one dust spot would be tedious, and the observer must have a knowledge of mineral optics as well as experience in microscope work in order to get good results. It is clear that the mineral composition of the rocks in the Witwatersrand mines is very favourable for counting the quartz particles in the dust, because the refractive indices concerned are very conveniently distributed. On this account an exact knowledge of the index of the immersion liquid is not wanted; it can be estimated closely enough by observation of powdered quartz and mica.

The application of the method to dust of less convenient composition, that is, dust made of minerals with overlapping indices, would require accurate knowledge of the index of the liquids used, and the solution of vaseline would have to be avoided.

ASSAYING METHODS AT GLOBE & PHŒNIX.

The April issue of the *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa contains a paper by H. R. Edmands, giving an account of the methods of assay at the Globe & Phœnix gold mines, Rhodesia. The author has introduced some variations in the usual practice.

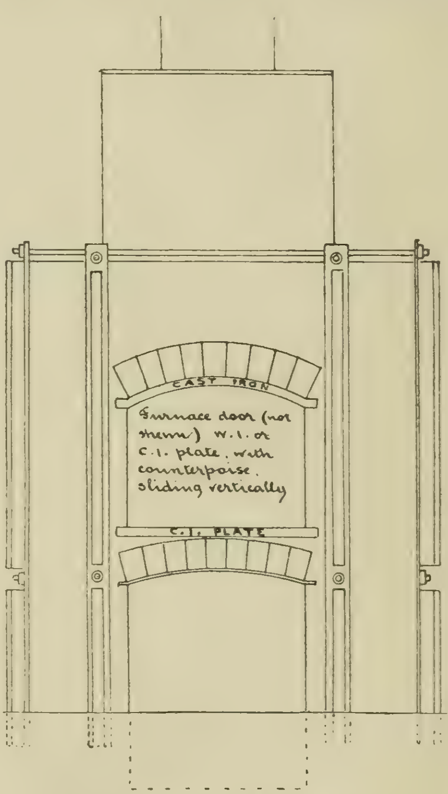
The ore presents no particular difficulties; it contains stibnite, averaging perhaps 2%, and although much of the gold is fairly fine, coarse gold is also frequently present. Some 1,600 to 1,800 assays are made per month, and it is seldom that a day's run much exceeds 100.

Just how far crushing before quartering should be carried depends on the even distribution, or otherwise, of the gold in the ore. Bearing in mind that a piece of ore 1 in. cube on being reduced to ½ in. cubes would be divided into 512 fragments, as against only 64 if reduced to $\frac{1}{4}$ in. cubes, the importance of fine crushing at this stage is evident. Coarse rolls following a breaker would in many cases be advisable. The more brittle or softer portions of the ore, being the first to be crushed, will be separated from the harder portions (carrying different values) by screening during crushing. A similar segregation occurs with disc pulverizers, and very thorough mixing of the ground product is required to get accurate results. Coarse gold will obviously cause discrepancies in duplicate assays. Although on crushing a sample to pass, say, a 60 mesh screen, the greater portion of the gold would be very much smaller, yet if the crushing is effected with frequent screening or by means of a disc pulverizer, which acts much as does a screen, the gold will not be so finely divided as it would be if the sample were crushed, say, in a ball-mill without removing any portion until the whole had attained the required degree of fineness. In the latter case attrition of gold continues throughout the grinding, in the former, some of the coarser gold is removed, when it will just pass the screen or escape between the plates of the pulverizer. More concordant results would be expected from crushing in ball-mills, and this is borne out by practice.

To eliminate as far as possible some of the sources of error alluded to, the author designed a ball-mill capable of taking the product of the breaker and reducing it at one operation to practically any degree of fineness required, this being regulated by the time of grinding and the weight of balls used. The mill is divided into two compartments, each taking a separate sample of about 600 or 800 gm. Its inside diameter is 11 in., each compartment being $3\frac{5}{8}$ in. wide. Two 3 in. balls are used in each compartment. The mill is driven at 70 r.p.m. by $1\frac{1}{2}$ in. belting, direct from a 2 in. countershaft, without pulleys, and the belt runs over the centre of the mill, which is slightly crowned. Each compartment of the mill is opened by one nut, and its contents emptied into a pan. It is then cleaned by compressed air. Eight such mills, taking 16 samples, are in use. The mills are cheap, readily accessible for cleaning, and wear is inconsiderable, very much less than with disc pulverizers; also as the wear is even, it does not affect the efficiency of the mill, which is not the case with disc pulverizers. The final product is perfectly mixed, and, no screening being required, is ready for assay. A reduction of native labour has been made since they have been used. Assays have checked better, and, although they are slower than disc pulverizers, their advantages outweigh this drawback, at least with this ore.

As regards battery discharge (screen) samples, lime is added to promote settlement, the clear water decanted, and the thick pulp well mixed. The portion taken for assay has most of its remaining water removed by an air-pressure filter, after which it can be quickly dried. This type of filter is quicker than, and preferable to, a vacuum filter, except when the cake requires washing, for which it is unsuitable, cracks being apt to form and cause channelling. The dried sample is ground for two hours in the ball-mill, when all passes a 100 mesh sieve, and 98% passes a 150 mesh sieve. Fine grinding is essential to get concordant results.

Reduction samples do not require fine grinding, all but the finest gold having been removed by amalgamation. These samples, containing dissolved gold, are treated as follows: The dissolved gold is precipitated, usually by adding cuprous chloride dissolved in brine to the pulp, and acidifying with sulphuric acid. The pulp is then filtered in the air-pressure filter and dried. This is not only much quicker than drying without filtration, but gives more accurate results. If the excess of barren solution be not removed by filtration, some of the gold is apt to re-dissolve on heating, and to form an enriched hard scale adhering firmly to the dish. In the case of richer solutions the author has found the error, presumably from this cause, to be quite considerable. In cases where much sulphocyanide is present, and precipitation by a cuprous salt is imperfect, an emulsion of finely ground charcoal should be substituted, or used in conjunction with the cuprous salt, when perfect precipitation is obtained.



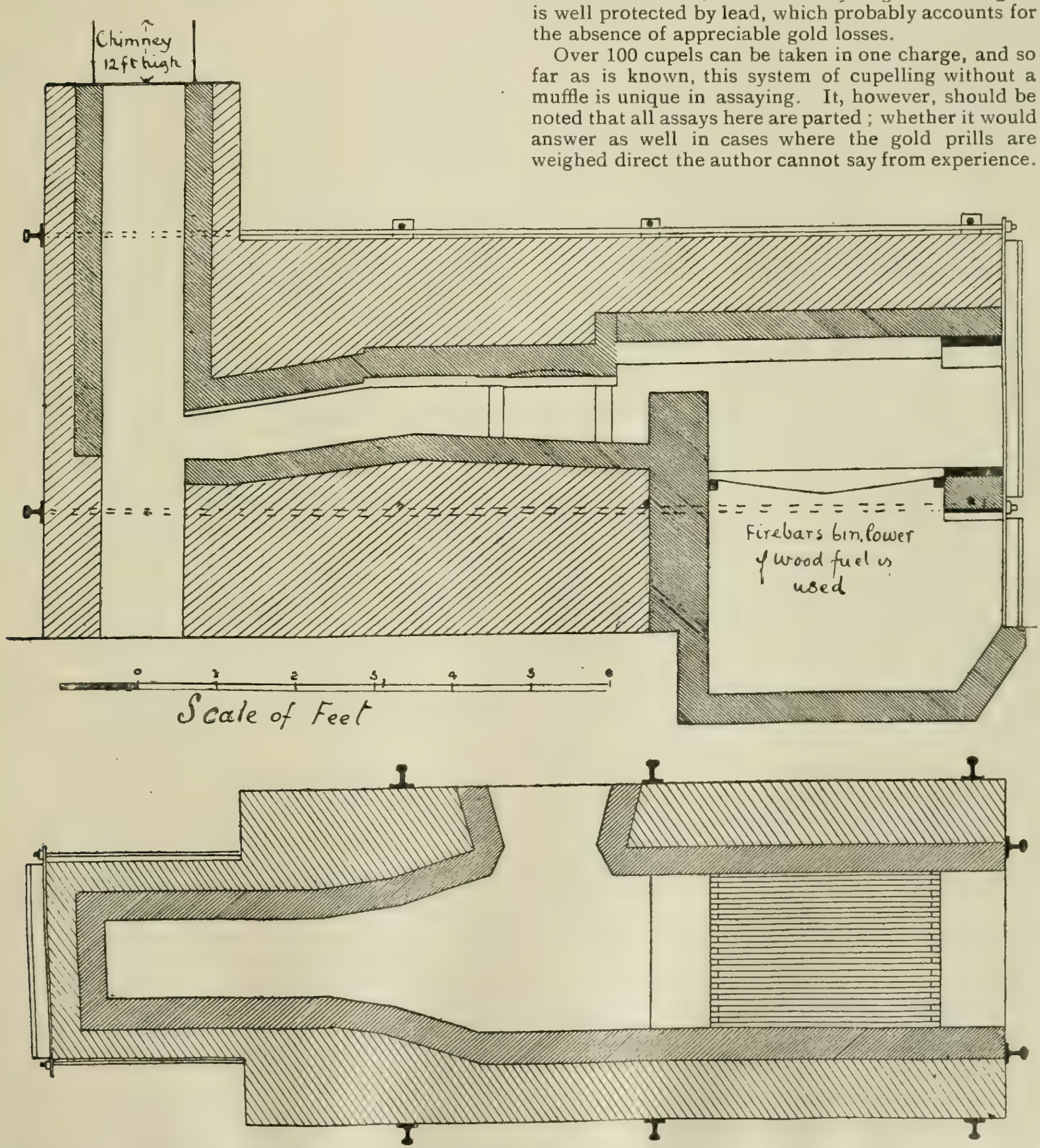
FRONT ELEVATION OF ASSAY-FURNACE.

As regards fluxing, the substitution of fluor-spar for borax, both wholly and in part, has been tried, but with unsatisfactory results. Mixing the ore and flux is effected by shaking in a large glass with a metal cover, to which is cemented soft sheet rubber. Mixing is more thorough and quicker than by the older method of rolling on glazed paper.

The coke-fired Cornish assay furnaces, formerly in use, have been replaced by a reverberatory furnace shown in the diagram. This type of furnace the author previously adopted in Western Australia for burning wood, and it follows the general lines of those used on the Rand. Both wood, wood and coal, and coal alone have been used, the first being much cheaper in Western Australia, and the last somewhat cheaper in South Africa. Special features are: (a) the abrupt lowering of the top arch just behind the firebridge, deflecting the flame on to the front row of pots. (b) The hearth is not level, but rises gently from bridge to flue, obviating the danger of pots falling backwards. (c) The hearth is covered with a layer of sand, or, preferably, of sifted earth, which absorbs any slag spilled. (d) The furnace has an independent stack with a damper at the top capable of very close regulation; the earlier type of furnaces had dampers at the base of the stack, and were burned out quickly. The furnace will take a charge of about 56 pots, usually 6 or 8 J's, and the remainder G's and F's; the heat is very uniform, and the pots last considerably longer than with Cornish furnaces. During fusion the damper is nearly closed, and a somewhat reducing atmosphere is maintained. Two charges of pots generally complete the day's work, after which the same furnace, without a muffle, is used for cupellation.

Cupellation is effected as follows: Bricks are placed on the hearth of the furnace to support wrought iron plates, each carrying about 25 cupels. The cupels are charged with lead buttons while they are cold. A good fire is made, and the damper opened rather more than when the pots are in. The atmosphere is reducing at first, but soon becomes oxidizing and cupellation proceeds steadily. Many checks have been made by re-cupelling prills of parted gold, but no loss of weight could be detected. Sir T. Kirke Rose has lately shown (Bulletin of the Institution of Mining and Metallurgy, March, 1919) that gold is not readily volatilized either in a reducing or an oxidizing atmosphere, but that losses are much greater when exposed to alternate reducing and oxidizing conditions. Such conditions occur here, but at an early stage when the gold is well protected by lead, which probably accounts for the absence of appreciable gold losses.

Over 100 cupels can be taken in one charge, and so far as is known, this system of cupelling without a muffle is unique in assaying. It, however, should be noted that all assays here are parted; whether it would answer as well in cases where the gold prills are weighed direct the author cannot say from experience.



LONGITUDINAL SECTION AND PLAN OF REVERBERATORY ASSAY-FURNACE AT GLOBE & PHŒNIX.

For the past 12 months cupels have been made from old used cupels, re-ground in a ball-mill. Their absorbent power is excellent, and they are in every way satisfactory. Cement, and mixtures of cement and mabor, were previously tried, but were not altogether satisfactory. An excellent cupel can, however, be made from a mixture of mabor and bone ash.

In parting, perforated sheet-iron trays, each carrying 24 parting cups, and fitting over an electric hot plate, are used. Failing an electric hot plate, parting can be done over the hot cupels, covering the latter with a sheet of ⅛ in. copper to more evenly distribute the heat. Waste acid, after precipitation of silver, is sent to the smelting house and used in cleansing bullion. The recovered silver is made into silver nitrate. For annealing, the tray of parting cups is allowed to rest a few seconds on a red hot cast-iron plate of the same diameter as the hot plate.

As regards solution assays, precipitation by a cuprous salt has hitherto been the practice here, and correct results are obtained on fairly clean solutions. Instead of adding cupric sulphate, sodium sulphite, and hydrochloric acid better results were obtained by adding cuprous chloride dissolved in brine and acidifying with sulphuric acid. The cuprous chloride solution is made by dissolving 3 parts crystals cupric sulphate in 20 parts saturated salt solution, and reducing to the cuprous state by metallic copper. 15 cc. of this solution, which should be colourless, suffices for 20 A.T. solution to be assayed. Sulphuric acid must be used for acidifying as hydrochloric acid gives low results. The author prefers to scorify the precipitate, after drying, with a mixture of 2 parts of litharge to 1 part borax, with enough flour to give a suitable button Scorification is readily effected on the hearth of the reverberatory, and appears to be better than a pot fusion. Although this method is suitable for clean solutions, all copper methods give low results in presence of much impurity, especially of sulphocyanides. Ferrocyanides also interfere, but to a less degree. The zinc and lead acetate method is much less sensitive to the more commonly found impurities, but was not used here owing to the impossibility of getting a clean lead sponge. A modification of this method has, however, lately been adopted, in which the assay is made without heating the solution.

As filtration and fusion of the precipitate previous to cupellation are in any case necessary here, and as precipitation is complete in the cold, much time and some expense are saved by the omission of heating. The procedure is as follows: To 20 A.T. of solution add 5 gm. zinc dust with vigorous stirring, then enough silver nitrate to ensure parting, and 40 cc. of 20% lead acetate solution, again with thorough stirring. Finally add 30 cc. hydrochloric acid cautiously, and stir until all action ceases. Filter and scorify with the same flux as used for the copper method, but with the addition of powdered glass. Nearly all the zinc is eliminated by the acid, and the remainder by scorification. Scorification is often troublesome in a muffle, where the space is limited, but this does not apply to the hearth of a reverberatory. This method is found to give accurate results on all but the most impure solutions.

Coal Mining in China.—The *Far Eastern Review* (Shanghai) for May contains some information about coal deposits and their exploitation in the Province of An-hwei (sometimes spelt Ngan-hwei). The article refers particularly to the Hsuan-cheng district, and the writer animadverts bitterly on the official obstruction to the development of the deposits.

This district is situated within the jurisdictional circuit of Wu-hu, a treaty port on the Yangtze River, the foreign settlement of which was opened in 1905. The city is 140 miles distant from Nanking, the southern capital of China. Fifteen capitalists have applied for permission either to prospect or to mine for coal in eleven distinct places, but so far only two have been given the requisite official permission to go ahead. To show the possibilities of the future in this district the writer outlines the present conditions in three of these places.

The first to be mentioned is the Niu-tzu Shan Mines. The area is claimed by two owners: one Mr. Ch'en, and one Mr. Wu. The mines first became known during the Ming Dynasty (A.D. 1368 1644). In 1910, the year preceding the Chinese Revolution, a Mr. Ch'eng first conceived the idea of working them on a share company basis, but the scheme fell through owing to the delay in obtaining proper official recognition. Until 1913 the mines changed ownership three or four times, but in that year an industrial development company was established and an English mining engineer was engaged to prospect. The following year the present Mr. Ch'en applied at the Peking Ministry for the necessary permission. At the same time Mr. Wu, representative of the industrial development company, also applied at the Ministry. On a technical ruling the Ministry gave the permission to Ch'en but withheld it from Wu, although the latter's company had been first registered at the Mining Bureau of Anhwei Province. After much controversy Wu consented to Chen's claim, since the latter's area was considerably smaller, and Ch'en was ordered to pay $8,215 to Wu as compensation. Ch'en demurred and an injunction order having been decreed against him until Wu had first been compensated, the matter reached a complete deadlock and permission is still withheld from both applicants. According to investigations, in the mines operated by the above Ch'en, coal was discovered at a depth of 40 ft. from the surface, the seams being of an average thickness of 2 ft. The strike runs from north-east to south-west and the dip is south-east at an angle of 20°. The coal here is high in carbon and is smokeless. The following is an analysis: Carbon 82%, sp. gr. 1·37, ash 4·78%, nitrogen 8·47%, hydrogen 4·75%. The mines are worked at present by primitive methods.

The next group of workings mentioned by the author is the Mien-niu Mountain Mines. As in the case of the Niu-tzu Shan mines, these mines are known to have been first worked during the Ming Dynasty. In course of centuries most people seemed to have forgotten all about them, until a few years ago the natives of the locality suddenly struck coal within almost a few feet of their own doors. Two of these at once began to dig for coal without so much as obtaining any official permission therefor. Then the officials got wind of their clandestine operations and at once prohibited further working. Other merchants became interested, but are still unable to raise the official interdiction. The quality of the coal here is inferior to that of the Niu-tzu Shan mines, being more smoky, bearing traces of sulphur, and containing much hard ash.

The Shuihsiang Mines is one of the two officially sanctioned mines, its permit dating from November 11, 1915. The owner is Mr. Yang Hsi-fu. It was first discovered about the end of the Ming Dynasty or the beginning of the 17th century, this being also proved by the number of old pits all over the locality. In 1906-1907 the Tsing K'ang company started prospecting operations, and coal was reached at a depth of

150 ft. Toward the end of 1913 the present An P'ing company arrived on the scene and forthwith applied for the requisite official permission at the provincial mining bureau, etc. Considerable red tapeism had to be gone through by this company, and two years afterward the permit was granted by the Ministry in Peking. When the mines were first developed in 1913 the methods employed were the usual primitive appliances, for instance, feet-driven bamboo fly-chains to bail out the water. Subsequently when the amount of water encountered at a depth of 300 ft. increased, modern pumps were installed, as well as boilers and a windmill for operating the ventilators. The quality of the coal and the extent of the deposit are yet to be ascertained. But samples show that it is of a superior grade to that at Mien-niu. The An P'ing company has a paid-up capital of $100,000.

Uses of Selenium and Tellurium.—The *Journal of Industrial and Engineering Chemistry* for June reprints a report by Victor Lenher, presented at the April meeting of the American Chemical Society, in which he reviews the present uses of selenium and tellurium and discusses the possibility of increasing their consumption. A recent estimate of the amount that can be produced in the United States, without making any material additions to the present plants, has shown that the United States can furnish more than 300,000 lb. of selenium and about 125,000 lb. of tellurium annually, figures far beyond the actual consumption. This produce comes entirely from the electrolytic copper refineries. The substances are commonly marketed in elemental form, although some of the refineries have produced small quantities of derivatives such as sodium selenite and tellurium dioxide.

The chemical characteristics of these two elements closely follow those of sulphur; indeed, the types of selenium and tellurium compounds are in general those of sulphur, but owing to their higher atomic weights they are more metallic. Tellurium in elemental form looks much like antimony. It is white and so strongly crystalline that it is quite brittle and can be easily powdered. Toward acids it is as refractory as antimony. Toward alkaline solutions it is strongly resistant, while in water or in moist air it does not rust or corrode appreciably. It is known that antimony can be used in electroplating and gives a durable plating. It would be interesting to study tellurium in this direction. A systematic study of the available electrolytes that can hold tellurium in solution could be carried out advantageously. Antimony has been successfully used for many years in antifriction alloys and is an essential constituent of stereotype metal. No recorded study is known of an attempt to utilize tellurium in these alloys, but the whole field of the metallic alloys of tellurium needs to be studied carefully, and unquestionably an element whose general characteristics are so close to antimony will be found a useful metal instead of having no practical applications. Another metallurgical line which has not been studied in any detail is the action of these two elements in the iron and steel industry. The effects of sulphur and phosphorus on iron and steel have been carefully studied. It is interesting to contemplate what careful experimentation might develop on the influence of selenium and tellurium on the various grades of steel.

Selenium in the so-called metallic form has long been characterized by its action toward light. Its conductivity of the current varies so greatly when brought from the dark into the light that this peculiar property has caused the development of the selenium cell. This cell or resistance apparatus has found numerous uses at various times, such as automatically turning off city gas lights at daylight. It has been used in lighting and extinguishing the lights in light buoys, in army signalling of various kinds based on the heliographic principle, as a control in chemical processes such as the contact sulphuric acid manufacture, and in wireless telephones.

It has been known for a long time that selenium gives a red colour to glass. During the war this principle was made use of in decolorizing glass on account of the shortage of manganese, the colour being used to counteract the green due to iron content. Selenium is introduced into the glass either in the elemental form or as a salt. As the rose colour which it imparts is not exactly the complement of the green of ferrous iron, it is common practice to add a small amount of cobalt oxide along with the selenium. Since both selenium and its compounds are very readily volatile at such temperatures as are used in glass making, a large amount of the selenium decolorizer is volatilized. The loss of selenium is therefore high, and selenium can be used to decolorize glass only when the glass manufacturers are willing to pay the higher cost price. As soon as shipping was resumed after the war and manganese again became available, the use of selenium in the glass business fell to almost nothing.

A number of possible uses for these elements suggest themselves, none of which have received the attention that they deserve. Lithopone, the intimate mixture of barium sulphate and zinc sulphide made by bringing together barium sulphide and zinc sulphate, is full of suggestions. Various coloured lithopones can be produced by using an antimony sulphate liquor with barium sulphide, when the white barium sulphate is coloured by the orange sulphide of antimony. Similarly, cadmium or arsenic liquors give a corresponding yellow lithopone. The substitution of selenium and tellurium is very suggestive, inasmuch as it should be possible to replace the sulphur of either the sulphate or the sulphide by either of these elements. The selenate and tellurate of barium are white and insoluble like the sulphate, while the selenides and tellurides like many of the metallic sulphides are variously coloured.

The use of the various compounds of selenium in medicine has received some attention, but the derivatives have had almost no systematic study. In a very careful study Prof. W. J. Gies, of Columbia University, has shown that tellurium compounds have a physiological action similar to that of arsenic, but that their toxicity is much less. The selenides and tellurides as well as the oxidized salts have been experimented with in cancer, tumours, and syphilis, but their efficacy is more or less questionable. These few compounds which are of the simplest chemical character are almost the only ones of which any experimental results are recorded. When one considers the vast field of important and valuable sulphur-containing medicinals ranging from saccharine to sulphur itself and in the arsenicals from Fowler's solution to salvarsan, it would seem that there exists an almost entirely new field for research by the physiological chemist. The offensive garlic odour of the "tellurium breath" will unquestionably act as a deterrent in the minds of some, but should certain physiological actions be found, they might be so valuable as to overcome the objections due to the characteristic methyl telluride odour.

In the vulcanization of rubber a few experiments are recorded which seem to indicate the similarity of the action of selenium to that of sulphur. Much remains to be done, especially along the lines of the use of the chlorides or bromides of these elements as accelerators. Tellurium and its derivatives have received practically no attention in the rubber industry. Possibly from the nature of the organic materials present, the objectionable methyl telluride would again militate against its use.

A relatively small amount of research has been conducted with selenium in the dye industry, while nothing has been done along these lines with tellurium. One of the first applications which would naturally occur would be the substitution of selenium for sulphur in the so-called sulphur colours, which are among the cheapest colours. There are at present two serious obstacles in the replacement of sulphur by selenium. The first is the relative cost of the selenium. The second is the nature of the bath which, in the present development of the sulphur colour process, would make the cost prohibitive. There is, however, the possibility that there might be found a brilliant and fast colour of considerable intensity which could be manufactured profitably. The field of synthetic dyestuffs possesses great opportunities for experiment and is almost undeveloped.

SHORT NOTICES

Bucyrus Diggers.—*Engineering* for June 18 contains an article describing the application of the Bucyrus diggers to the digging of foundations for houses and other buildings.

Rock-Drills.—In the *Engineering and Mining Journal* for June 5, G. H. Gilman writes on the standardization of hose-fittings for hammer-drills.

Shaft-Sinking Through Quicksand.—The *Colliery Guardian* for May 28 contains a translation of an article in *Annales des Mines de Belgique* on shaft-sinking through quicksand by the freezing process at coal mines at Beeringen.

Flotation at Broken Hill.—*Proceedings* No. 36, 1919, of the Australasian Institute of Mining and Metallurgy contains a paper by C. C. Freeman on froth-flotation at Broken Hill.

Flotation of Molybdenite.—In the *Engineering and Mining Journal* for May 29, W. H. Coghill and J. P. Bonardi describe the flotation of molybdenite at the Urad mine, near Empire, Colorado.

Copper Smelting.—In *Chemical and Metallurgical Engineering* for June 16, C. G. Maier and G. D. Van Arsdale commence an article reviewing chemical and microscopic methods of examining copper slags, in connection chiefly with the existence of copper and magnetite in the slags.

Metallurgy at Trail.—In the *Mining and Scientific Press* for June 12, F. H. Mason reviews present metallurgical practice at the Trail smelter, British Columbia, where zinc, lead, and copper are all refined electrolytically.

Determination of Tungsten.—The *Mining and Scientific Press* for June 12 contains a paper by G. M. Enos, describing a volumetric method for the determination of tungsten.

Estimation of Zirconium.—The *Journal of Industrial and Engineering Chemistry* for June contains a paper by G. E. F. Lundell and H. B. Knowles on the estimation of zirconium in steel.

Determination of Molybdenum.—The *Journal of Industrial and Engineering Chemistry* for June contains a paper by Walter Scott on the application of the rotating zinc reductor in the determination of molybdenum.

Estimation of Arsenic.—At the May meeting of the Nottingham section of the Society of Chemical Industry, J. M. Wilkie read a paper on the electrolytic method of estimating arsenic.

Ores of Premier Mine, B.C.—In the *Canadian Mining Journal* for June 4, Victor Dolmage discusses the mineral constitution of the silver-gold ores of the Salmon River or Stewart district of northern British Columbia, where the Premier mine has recently attracted so much attention.

Dolly Varden Mine.—In the *Mining and Scientific Press* for May 1, A. J. T. Taylor gives the history of the Dolly Varden silver mine, in northern British Columbia.

Indian Manganese.—In the *Engineering and Mining Journal* for May 22, E. N. T. Slater writes on the mining of manganese ore in India.

Jerome, Arizona.—*Mining and Metallurgy* for May (the organ of the American Institute of Mining and Metallurgical Engineers) contains brief abstracts of two papers to be presented at the August meeting of the Institute; one on the Geology and Ore Deposits of Jerome Copper District, by L. E. Reber; and one on Mining Methods at the United Verde copper mine. Papers issued by the Institute are now only sent to members on demand.

Diamonds.—In the *Engineering and Mining Journal* for May 29, Sydney H. Ball writes on the occurrence of diamonds throughout the world.

Reinforced Lead.—In *Chemical and Metallurgical Engineering* for June 9, Charles Baskerville and C. M. Wales give details of chemical lead pipes and sheets which are strengthened with internal sheets of iron wire gauze or punched iron.

Permanganates.—In *Chemical and Metallurgical Engineering* for June 2, R. B. Stringfield describes the method of manufacture of sodium and potassium permanganates in California, an industry established during the war.

Colombian Petroleum Law.—In the *Engineering and Mining Journal* for May 22, J. W. Thompson gives an outline of the new petroleum law of Colombia.

RECENT PATENTS PUBLISHED.

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 1s. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.2., with a note of the number and year of the patent.*

4,622 of 1919 (143 619). Central Mining and Investment Corporation, Johannesburg. In the electrolytic deposition of gold from cyanide solutions upon permeable cathodes of graphite, forming the cathodes of 25% paper pulp and 75% graphite.

4,623 of 1919 (143,620). Central Mining and Investment Corporation, Johannesburg. In the process mentioned in the previous specification, removing oxygen from the solution before precipitation, by subjecting the solution to a vacuum or otherwise.

7,636 of 1919 (143,674). S. O. Cowper-Coles, London. Improvements in the inventor's process of "sherardizing," that is, coating iron with zinc under heat.

7,725 of 1919 (142,618). E. H. Moyle, Los Angeles, U.S.A. Improvements in rock-breakers of the jaw type.

9,032 of 1919 (142,989). T. J. Sturtevant, Massachusetts. Improvements in sizing screens of the vibratory type.

11,655 of 1919 (143,383). S. G. Musser, Los Angeles, U.S.A. A centrifugal amalgamator.

12,593 of 1919 (143,710). G. E. Sibbett and L. D. Hopfield, Natoma, California. Improved construction of the lips of dredge buckets.

19,388 of 1919 (131,289). Société Industrielle de Produits Chimiques, Paris. Method of transforming sodium monochromate into bichromate or chromic acid.

19,398 of 1919 (139,749). WILLIAMS PATENT CRUSHER & PULVERIZER CO., and A. J. ROBERTS, St. Louis, U.S.A. A pneumatic separator for minerals.

20,386 of 1919 (142,721). GENERAL ELECTRIC CO., Schenectady, New York. An improved method of producing magnesia lining for furnaces.

21,038 of 1919 (131,896). DEUTSCHE MOLYBDAEN WERKE, Halle, Germany. Production of ferro-molybdenum by acting on a molybdate of an alkali earth with iron in presence of a reducing agent such as carbon.

22,076 of 1919 (140,011). GENERAL ELECTRIC CO., Schenectady, New York. The use of "fibrox" (silicon oxycarbide) as a support for catalysing agents.

25,529 of 1919 (136,145). M. LESSER, Pretoria. A concentrator consisting of a travelling belt suspended under water and given a vibratory movement.

25,757 of 1919 (143,786). R. HEGINBOTHAM, Sheffield. Dies for use in sharpening rock-drills and coal-cutters.

32,568 of 1919 (137,296). FABRIQUE DE PRODUITS CHIMIQUE DE THANN ET DE MULHOUSE, Alsace. Method of making potassium sulphate from bisulphate and chloride of potash.

2,581 of 1920 (141,001). UNITED FILTERS CORPORATION, New York. Improved shaft and distributing pipes for rotating filters with sectionalized leafs.

18,536 of 1919 (132,496). NORSK HYDRO-ELEKTRISK KVAELSTOFAKTIESELKAB, Kristiania, Norway. Making a fertilizer containing phosphorus and nitrogen by a reaction between phosphate rock and urea salts.

NEW BOOKS, PAMPHLETS, Etc.

☛ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 723, Salisbury House, London Wall, E.C.2.

Electrical Practice in Collieries. 5th Edition. By Professor DANIEL BURNS. Cloth, octavo, 420 pages, illustrated. Price 10s. 6d. net. London: Charles Griffin & Co., Ltd.

The electrification of mines and collieries continues to grow apace, and this growth is accompanied by marked improvements in the methods of applying the power to the special requirements of the mines. There are few collieries of any size or within reasonable distance of a supply station at which electricity is not used as a motive power, and the equipment at many of the more important mines compares favourably with that at large modern engineering works and electric power stations. So rapid has been the development in recent years that a book dealing with the subject soon becomes out-of-date unless the subject is brought under frequent revision. The book under review has been fortunate in this respect, as, owing to a well-deserved popularity among mining students, it has reached a fifth edition in a relatively short period. In the present edition much additional matter has been introduced. In particular the author has devoted greater attention to alternating currents than in the previous issues. The properties of three-phase alternating currents and the methods of measurement are fairly adequately treated, and the new section dealing with capacity and wattmeters greatly enhances the value of this part of the work. The reviewer is strongly of the opinion, however, that there is room for a much fuller discussion of the properties and application of three-phase alternators and induction motors than the author has presumably deemed sufficient. Whatever may have been the view of mining engineers in the past, there can be little question but that three-phase power for the general purposes of mines is in many respects superior to direct current. The disadvantage of the low power factor referred to on page 143, although a real drawback, is effectively counterbalanced by greater flexibility both in transmission and in use. Moreover, electrical ingenuity, by various means, has now to a large extent overcome the stigma of the low power factor. Another point which it would seem the author has omitted to emphasize relates to the growing practice of high-tension generation, transmission, and use. A perusal of the book leaves the impression on the reader that high-tension motors are little used underground, whereas this is far from being the case. Indeed it is now considered good practice to carry the power at high tension to the shaft bottom and often further into the workings, to operate the larger stationary motors at higher voltage, especially pump motors, and to transform down only for coal-cutters, conveyors, and the smaller stationary motors. The reviewer does not mean to imply that high-tension transmission and use is altogether ignored in this book, for this is not so, reference being made to the matter toward the end of the chapter on motors and elsewhere in the book. All that he desires to point out is that, in his opinion, the subject is one that deserves somewhat fuller treatment than it has received. With respect to other parts of the book, some good matter has been added to the section on winding; in Chapter I a useful exposition of Joule's law and a method of testing earth resistances are given; while in Chapter IV the explanatory notes on torque will be found helpful to students. In Chapter III the running of dynamos in parallel receives more attention than formerly. The list of "approved" electric safety lamps in Chapter X is not by any means up-to-date, but the lamps selected for description are still extensively used. On the whole the book is one of the best of existing treatises on electrical mining practice from the points of view both of the mining student and the engineer.

DAVID PENMAN.

Recherches Geologiques et Petrographiques sur le District Minier de Nicolai-Pawda. By L. Duparc and A. Grosset. Geneva: Librairie Kundig; Paris: Dunod et Pinat.

L. Duparc and A. Grosset's book on "Geological and Petrographical Research Work of the Mining District of Nicolaï-Pawda," consists chiefly of a treatise on the various rocks found by the authors while engaged in the compilation of a geological map of the Nicolaï-Pawda estate, situated in the Ural mountains. The book is subdivided into eleven chapters, these being preceded by introductory remarks spread over 24 pages. The first three chapters deal with the topography, hydrography, and geology of the estate, the following seven chapters with a minute mineralogical and petrographical study of the various rocks encountered. Chapter X refers to the metalliferous deposits, and Chapter XI to the platinum deposits. As regards the mineralogical and petrographical work the book constitutes a useful addition to the eighty publications cited by the authors as referring to various geological studies of the Ural mountains. Forty-two of these publications are due to Duparc. His work in connection with the origin of platinum deposits is most painstaking, thorough, and convincing from the theoretical point of view. The book under review is no exception in this respect, but it is to be sincerely regretted that it has apparently been rather hurriedly compiled, with the result that it contains quite a number of shortcomings.

The hurried writing is to be found throughout and may be gathered from sentences like the following (p. 29): "It must, however, be pointed out that these (river) sections are never homogeneous, and that often, even in the third part of their course, their width may be much less, especially in the strangulated portions."

Other criticisms to be offered are the following: (1) Measurements lack in uniformity. They are given indiscriminately in Russian, metric, and English units. Weights are similarly intermixed.

(2) The constant use of Russian (and foreign) expressions, unknown to the majority, renders the reading of the book rather tedious. Why use in the text such words as: Proseka, Vizirka, Quartal, Datcha, Ouval, Lojok, Gragne, Retchniki, Peski, and many others, all of which have specific equivalents in the language in which the book is written. They should be mentioned in foot notes but not in the text. As an example a few lines may be quoted from page 262: "On the *lojok* Porphyrowka, a tributary of the Baïkowka, 4 *kilometres* to the N. of Pawda and to the W. of the Soukhogorsky road, the old workings extend over ¾ *versts*. The section is the following:

Tourbe (peat)	= 0·5 – 1·16 metres.	
Argile (clay)	= 0·7	,,
Peskis (sands)	= 1·8	,,

and on page 278:

1.	Tourbe et terrain superficiels	½ archine.
2.	Retchnikis (river gravel)	7 ,,
3.	Peskis	3 ,,
4.	Bed-rock	Amphibolite.

"Le platine était presque entierement contenu dans les 20 centimetres de peskis situés directement au-dessus du bed-rock."

(3) The chapter dealing with the metalliferous deposits appears very superficial from a practical point of view; possibilities are hinted at, but the intrinsic value of most of the deposits is left to the judgment of the reader, and is not dealt with by the authors as one is led to expect from the introductory remarks.

(4) While the study of the platinum deposits from the theoretical point of view is all that can be desired, some statements as to future possibilities are rather unfortunate, such as on page 290: "The distance from the mouth of the river Bolchaïa-Kamenouchka to where the dredge is now standing, approximates 45 kilometres. Assuming a width of only 50 sajenes for the workable alluvial strip, and an average depth of 4 archines, the total cubic contents to be extracted would amount to 1,567,750 cubic sajenes, which would feed 4 dredges of 7½ cu. ft. for 10 years." The platinum which may be expected from this strip is, however, not hinted at, and this, after all, is more important than the dredging of any assumed quantity of gravel.

Microscopic Examination of Ore Minerals. By W. M. Davy and C. M. Farnham. Cloth, octavo, 164 pages. Price, 15s. New York and London: McGraw-Hill Book Company.

The past decade has witnessed a marked development of the use of the reflecting microscope for the identification of opaque minerals in polished specimens of ore deposits. The first book on the subject, by Murdoch, was published as recently as 1916; and now we have a second by authors who have continued the investigation of Murdoch's collection of ores, and have modified his treatment of the subject in the light of new data and experience. As a contribution to petrographic methods of a most practical and illuminating kind the book is invaluable, and it should do much to stimulate interest in a subject which has hitherto received but scant attention in this country. The pioneer stage is now passed, but much more experimental work remains to be done before the methods can be standardized into a regular routine. Considering the pre-eminence of British researches in metallography we may perhaps hope that valuable British contributions to technique may yet be made, but in the meantime most of us must go to American literature for preliminary guidance.

It should, however, be mentioned here that Professor Cullis, of the Royal School of Mines, has already devised a simple modification of the ordinary procedure which permits the study of both transparent gangue minerals and opaque ores in the same section.

As stated below, most thin sections are not polished, but by the slight additional labour of polishing their upper surfaces and leaving the latter uncovered, most of the tests ordinarily applied to polished surfaces can be successfully carried out. After the work of identification has been completed, the preparation may then be protected with a cover-glass in the usual way.

An ordinary petrographic microscope may be used if it can be fitted with a vertical illuminating prism or a silvered reflecting surface above the objective. Otherwise a metallographic microscope is necessary.

Polished opaque minerals do not necessarily give the same colours as those seen in ordinary thin sections, which are "smooth" but not polished. Opaque minerals appear white, grey, or otherwise coloured, while transparent gangue minerals are black, or at least conspicuously darker than the ore minerals. Although most ores appear white or grey some show characteristic colours which serve to identify them. Others give brightly coloured internal reflections when strong light impinges obliquely on the polished surface, thus:

Colours by Vertical Reflection.	Minerals
Blue	Covellite
Yellow	Chalcopyrite
,, ...	Gold
Cream	Pyrite
,, ...	Pyrrhotite
Pink	Copper
Brown	Bornite

Colours by Inclined Internal Reflection.	Minerals.
Red	Cinnabar
,, ...	Cuprite
Red-brown	Limonite
Yellow-brown	Cassiterite
,, ...	Zinc Blende
Orange	Realgar
Yellow	Orpiment

With the above exceptions colour rarely serves for identification, and the behaviour of the minerals under investigation toward a series of reagents is used as the chief criterion for attaining the desired information. Reagents are applied by means of a capillary pipette, or by touching the surface with a piece of blotting paper soaked with the reagent. Those used by Murdoch, and Davy and Farnham are:

(*a*) HNO_3, (*b*) HCl — Concentrated acid and distilled water in equal proportions.

(*c*) KCN, (*d*) $FeCl_3$ — 20% solution in water.

(*e*) $HgCl_2$, (*f*) KOH — Saturated solution in water.

These are applied systematically in turn and negative or positive results noticed. A positive result

DETERMINATIVE TABLE FOR SOME COMMON OPAQUE ORE MINERALS.

HCl	KCN	$FeCl_3$	Hardness	Mineral reacts with Nitric Acid: With Effervescence	Mineral reacts with Nitric Acid: Without Effervescence	Mineral gives no Reaction with Nitric Acid
R	R	R	M	Cuprite, grey-white (red)		
R	R	R	L		Argentite, grey-white	Pyrolusite, brown
R	—	R	L	Native silver, creamy white	Galena, galena-white	
—	R	R	L	Native copper, pink Chalcocite, bluish white		Cerargyrite, grey-white (red) Proustite, blue-white (red)
—	R	—	L	Bornite, pinkish brown	Stibnite, galena-white	Pyrargyrite, grey-white (red) Covellite, blue Gold, yellow
—	—	R	H	Niccolite, creamy white Smaltite, white	Chloanthite, white	Uraninite, grey
—	—	R	L	Realgar, grey-white (orange) Jamesonite, grey-white	Molybdenite, grey-white	
—	—	—	H	Mispickel, white Pyrite, Marcasite } creamy white		Cobaltite, pinkish white Hematite, creamy white Magnetite, Ilmenite, Rutile, Wolfram } grey-white Chromite, grey Cassiterite, grey (yellow-brown) Limonite, grey (red-brown)
—	—	—	M		Pyrrhotite, cream Zinc-blende, grey (yellow-brown)	Chalcopyrite, yellow Tetrahedrite, grey-white
—	—	—	L			Cinnabar, grey-white (red)

may involve effervescence, tarnishing, etching, or development of cracks or cleavages.

Davy and Farnham's book consists largely of tables in which minerals are classified according to their behaviour with the first four of the reagents mentioned, together with their relative hardness as tested by a sharp needle. The hardness categories are three :

L. *Low Hardness:* scratching easily achieved without pressure or with very light pressure (1–3).

M. *Medium Hardness:* scratching slight with light pressure and conspicuous with heavy pressure (3–4·5).

H. *High Hardness:* scratching very slight or absent even with heavy pressure (4·5–9).

The adjoining table illustrates the principle of the classification. In the columns on the left, the letter R means a positive reaction and its absence implies a negative result. The authors give the hardness test after the KCN test and before the $FeCl_3$ test. The order here adopted, however, seems preferable. Naturally the classification arrived at in this way is not always sharp, but no difficulty arises, as a mineral which falls near the hardness limits, or which may give a slight reaction that generally would not be noticed, can be repeated in appropriate places so that it need not be overlooked. In the table the vertical reflection colours are given after each mineral, those in brackets, however, being the colours seen by inclined and internally reflected light. The colour of the powder (streak) produced by the hardness test also has determinative value.

It is not necessary here to enter further into the outlines of the methods adopted and the tests applied. The authors point out that in the determination of minerals it is unnecessary to depend on "mineragraphic" tests alone. Out of a group of possible minerals one can generally be run down confidently by gouging out a small piece and subjecting it to blowpipe or microchemical tests. For this reason the latter part of the book consists of lists of the chief determinative tests for the elements, the latter being arranged in alphabetical order and the minerals in which each occurs as a noteworthy constituent being also given.

In the chapter dealing with technique some discussion of the electrical conductivity of minerals and their electropotential is entered into. A chapter is also devoted to photomicrography of polished surfaces. It is perhaps too early in the evolution of the group of methods outlined in the book to expect a critical study of the results of their application to problems of order of deposition and genesis of ore deposits, but it is to be hoped that in future editions, which will undoubtedly be called for, this important aspect of the subject will be dealt with. Only so can the dry bones of experimental observation be animated with the spirit of research.

In conclusion the writer would like to enter a protest against the term *mineragraphy* which is used "to designate the art of polishing, identifying, and examining the ore minerals under the metallographic microscope." The term dates only from 1917, and the authors admit that it is "not altogether pleasing." While there is yet time let us have a name for this branch of economic geology sufficiently pleasing to attract the attention to the subject that it deserves. ARTHUR HOLMES.

An Introduction to Palæontology. By A. MORLEY DAVIES, D.Sc., F.G.S., pp. xi. + 414, with frontispiece and 100 figures. Cloth, octavo, 420 pages, with 100 illustrations. Price 12s. 6d. net. London: T. Murby & Co.

At the present time there is a great need for a book on palæontology which will enable the practical geologist to identify readily the fossils which he may find in the course of his field-work, and thus to fix the age of stratified rocks. This is admittedly a very difficult thing to provide, and no existing book is quite satisfactory. The tendency of all palæontologists is to give too much detail, especially with regard to minute points of distinction in nomenclature. Dr. Morley Davies has not succeeded in avoiding this pitfall; in fact he has fallen into it to an excessive degree. Thus, we find the old and well-known genus Rhynchonella split up into 9 subgenera, nearly all of which are quite unrecognizable under their new names, except to a specialist. This kind of thing is all the more unfortunate, in that the general idea of the book is good. A typical member of each group is first described in some detail, with figures, and then the characteristics of related forms are more briefly indicated. This is really an excellent method, if excessive specialization be avoided. There are certain remarkable features in the general classification adopted. For instance, it is not clear why the vertebrates are sandwiched in between the trilobites and the sea-urchins, and zoologists will cavil at the birds being regarded as a class of reptiles. There is a most useful chapter on the collection and preservation of fossils, and this is followed by a discussion of the rules of nomenclature, which is of extraordinary interest as an example of the lengths to which pedantry can be carried. Thus, it is somewhat startling to find that "*Cardita deltoidea* (J. Sowerby)" is quite a different thing from "*Cardita deltoidea*, J. Sowerby." At the end of the book are given tables of the subdivisions of geological time and the various fossils characteristic of each. Here again the passion for multiplicity of names comes out in full force, and the minuteness and complexity of the classification and nomenclature here adopted will be a revelation to many academic geologists, and a source of bewilderment to the practical man, who wants to know whether the fossil he has found is a Jurassic ammonite or a Carboniferous gastropod, and is not likely to be concerned with such horrors as *Crickites holzapfeli* or *Waagenoceras mojsisovicsi*. We fear that the text-book of palæontology suitable for the economic geologist yet remains to be written.

The Analysis of Silicate and Carbonate Rocks. By W. F. HILLEBRAND. Bulletin 700, United States Geological Survey.

This is a revised and enlarged edition of Hillebrand's well-known work on the analysis of rocks. Its gradual evolution, and its unrivalled success as the standard text-book on the subject, is indicated by the fact that it began as Bulletin 148, and that successive revisions, bringing it always abreast of the progress of research, have appeared under the numbers 176, 305, 422, and 700. The book is now a general treatise on rock analysis, invaluable to the chemist, the geologist and mineralogist, and the cement worker. The new matter includes a great deal of useful and cogent information concerning the working materials used in apparatus; the rôle played by hydrogen and water in minerals; and specific gravity determinations; as well as detailed accounts of the more promising of the new methods and modifications which have been devised during the past decade for the determination of individual constituents and the separation of complex precipitates. The authority of the author stands so high, and his influence in bringing rock analysis to its present status has been so great, that it is unnecessary to indulge in praise of his work. The book has often been described as a classic, but it is even more than that, for it lives and develops in response to the active growth of the subject which it reflects so faithfully. Scientific workers the world over, whether "pure" or "applied," will unite in thanking Dr. Hillebrand for presenting to them the results of his unique experience. The Bulletin is issued at a merely nominal cost by the United States Geological Survey, after a limited number of copies have been distributed to accredited workers free of charge.

ARTHUR HOLMES.

Hand Sketching for Mining Students. By G. A. Podge and N. Harwood. Second edition, enlarged. Price 10s. 6d. net. London: Crosby Lockwood & Son.

Mineral Resources of Alaska. Report on progress of investigations. By G. C. MARTIN and others. Bulletin 692 of the United States Geological Survey.

Bibliography of the Metals of the Platinum Group, 1748-1917. By J. L. HOWE and H. C. HOLTZ. Bulletin 694 of the United States Geological Survey.

Geographic Tables and Formulas. Fourth Edition. Compiled by SAMUEL S. GANNETT. Bulletin 650 of the United States Geological Survey.

Economic Geology of Gilpin County, Colorado. By EDSON S. BASTIN and JAMES M. HILL. Professional paper 94 of the United States Geological Survey.

Sunset-Midway Oilfield, California. Part 2; Geochemical relations of the oil, gas, and water. By G. SHERBURNE ROGERS. Professional paper 117 of the United States Geological Survey.

Deposits of Manganese Ore in Arizona. By E. L. JONES and F. L. RANSOME. Bulletin 710 D of the United States Geological Survey.

Deposits of Manganese Ore in Costa Rica and Panama. By JULIAN D. SEARS. Bulletin 710 C of the United States Geological Survey.

The Copper Deposits of Ray and Miami, Arizona. By F. L. RANSOME. Professional paper 115 of the United States Geological Survey.

The Divining Rod: A History of Water Witching. By ARTHUR J. ELLIS. Water-Supply Paper 416 of the United States Geological Survey.

Approximate Quantitative Microscopy of Pulverized Ores. By W. H. COGHILL and J. P. BONARDI. Technical Paper 211 of the United States Bureau of Mines.

Use of the Panoramic Camera in Topographic Surveying. By James W. Bagley. Bulletin 657 of the United States Geological Survey.

Aluminium: Its Manufacture, Manipulation, and Marketing. By GEORGE MORTIMER. Price 2s. 6d. net. London: Sir Isaac Pitman & Sons, Ltd.

Compressed Air Power: A Treatise on the Development and Transmission of Power by Compressed Air. By A. W. DAW and Z. W. DAW. Price 21s. net. London: Sir Isaac Pitman & Sons, Ltd.

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COMPANY REPORTS

City Deep.—Although a somewhat larger profit was earned last year by this Central Rand proposition, namely, £462,566 against £458,265 for 1918, the rate of dividend paid (23¾%) was 3¾% less than before. £68,274 was expended on capital account, and the annuity in respect of undermining rights leased from the Government took £6,560, while taxes absorbed £65,333 and the dividends £296,875. Of the profit, no less than £133,155 was contributed by the gold premium. The quantity of ore milled was 617,800 tons (against 670,100 tons in 1918) and working costs were 27s. 9d. per ton (against 24s. 8d.) The reduction in output and in the amount of development performed were due to a serious decline in the native labour supply, which, according to the consulting engineer, prevented justice being done to the capabilities of the mine. He describes the results of the past year's development work as "satisfactory, although not quite up to the average of the last two or three years," and states that in the lower part of the mine the prospects are good. At December 31 last the ore reserves were estimated at 3,418,050 tons of 9·4 dwt. value; the tonnage represents a slight increase but the grade shows a decline of 0·2 dwt. The manager's report shows that whereas the ore mined last year totalled 682,767 tons (of which 64,467 tons was discarded as waste) the payable ore developed in the same period was 573,400 tons.

Robinson Deep.—More than half the past year's working profit of £152,567 of this member of the Consolidated Gold Fields group of Rand mines was contributed by the gold premium. This yielded £93,548. The ore milled amounted to 580,500 tons (against 529,300 tons in 1918); the yield per ton was 31s. 2d. (against 26s. 11d.); and working costs averaged 25s. 11d. (against 25s. 8d.). In addition to the working profit, there was £5,408 sundry revenue, making a total of £157,975. Interest on loans, income tax, etc., absorbed £35,644, leaving a net profit of £122,331. The development footage for the year was 8,069, as compared with 8,143 ft. in 1918. O. P. Powell, the acting consulting engineer, reports that reef values and widths both continue good in the lower levels of the mine. The ore reserves at December 31 last were estimated at 1,583,000 tons of fully developed ore, averaging 6·59 dwt. over 62 in., and 20,000 tons of partly developed ore of an indicated value of 5·41 dwt. over 57 inches.

Simmer Deep.—Notwithstanding the fact that the premium on gold yielded this member of the Gold Fields group £57,615 last year—an amount equal to 2s. 3d. per ton of ore milled—the company was unable to make ends meet. The tonnage milled in 1919 was 508,900, or nearly 8,000 less than in the preceding year, and working costs were 23s. 7d. per ton, against 21s. 1d. The net outcome of the year's operations was a loss of £46,040, debenture service having taken £43,120. A further substantial loss having been incurred in the current year, the directors decided last month to suspend operations at the mine.

Rezende Mines.—The report of this Rhodesian gold-mining company for 1919 shows that the tonnage milled was 61,800 (against 54,000 in 1918), for a yield of 34,079 oz. (against 35,516 oz.). Working costs averaged 28s. 2d. per ton, or 1s. 7·7d. less than in the preceding year. The working profit, including £15,866 in respect of the gold premium, amounted to £91,161. The balance carried to appropriation account was £68,877 (against £41,561), £6,648 having been written off for depreciation and £8,793 for extraordinary expenditure, while Rhodesian income tax absorbed £5,445, and administration expenses £3,483. Dividends totalling 40% (against 20% for 1918) have been paid for the past year, and the directors have written off the £23,606 expenditure incurred on the Kent mines, the option thereon having been abandoned. They have also reduced by £8,741 to £1,000 the book item of the development of the Old West workings, now let on tribute. The ore reserves at the end of 1919 were estimated at 165,248 tons, valued at 10·72 dwt., as against 175,374 tons averaging 12·6 dwt. the year before. In this connection it must be remembered that the figures at the end of 1918 had shown a very great increase over anything previously recorded. The decline in quantity and value is due to the reduced widths met with in stoping between the 4th and 5th levels, and also to the fact that the development on the 5th and 6th levels exposed reef of considerably reduced width and value as compared with those on the 3rd and 4th levels for the previous year. At the date of this report (January 31, 1920) the values and widths exposed on the 6th level main drive east were reported to be showing a considerable improvement.

Great Boulder Proprietary.—This company was formed in London in 1894 to acquire gold-mining claims in Kalgoorlie, West Australia. Handsome dividends have been paid since 1895. Four years or so ago the prospects of further discoveries in depth became remote, but on the other hand development in the upper levels and the results of stoping operations have disclosed much additional ore. Sir George Doolette is chairman, and Richard Hamilton is manager, both having held the positions for many years. The report for the year 1919 shows a considerable fall in the output owing to the strike which affected all the Kalgoorlie mines, the mill having been stopped 129 days. The total ore treated amounted to 106,952 long tons, and the gold extracted had a par value of £316,315. The premium on gold brought an additional income of £54,273. The net profit was £165,396 (of which £54,273 was premium), out of which £121,250 has been distributed as dividend, being at the rate of 75%. During the previous year the tonnage was 152,196, the output of gold £484,210, and the dividend £196,875. The cost per long ton was 35s. 8d. as compared with 32s. 6d. the year before, a rise which was not so great as might have been expected, seeing that a smaller tonnage was treated. It will be seen, therefore, that except for the strike the results have been good. The reserve at December 31 was estimated at 325,314 tons averaging 14·56 dwt. per ton, as compared with 345,719 tons averaging 14·49 dwt. the year before; these figures show that the reserve has been maintained in a remarkable manner.

Golden Horse-Shoe.—The present company which owns this well-known Kalgoorlie mine attained its majority a few months ago. The mine has a fine record to its credit, nearly 3½ millions sterling have been paid in dividends to date from the production of 2,634,000 oz. of gold. The report for1919 shows that there was a fall in production owing to the strike, while costs continued on the up grade. The tonnage treated was 105,588 (against 146,664 in 1918) for a yield of 47,584 oz. of gold (against 77,096 oz.) If it had not been for the gold premium, which yielded £34,508, the net profit for the year would have amounted to only £3,681. As it was, there was a balance of £38,189, and a two-shilling dividend free of tax was paid, absorbing £30,000. On account of the current year a similar distribution was declared last month. J. W. Sutherland, the general manager, in his annual report, points out that owing principally to the scarcity of suitable underground men only a very limited amount of development work was possible, and the prospects of any great improvement in this direction are not very promising. As soon as conditions are more favourable, it is intended to resume sinking the main shaft in order to develop No. 4 lode at the 3,380 ft. level, where it is thought it should be in less disturbed country. At the end of 1919 the ore reserves were estimated at 678,292 tons averaging 9 dwt.; of this total 270,915 tons averaging 10·96 dwt. was on No. 4 lode.

Waihi Grand Junction.—At this New Zealand gold mine, working expenses and taxes exceeded revenue by £18,427 last year. The tonnage of ore treated was 66,530 (against 80,210 in 1918), and the value 32s. 1d. (against 38s. 3d.) per ton. The reduced output was due to the difficulty of obtaining adequate skilled labour, which also seriously hampered development. At the end of 1919 the ore reserves were estimated at 90,450 tons, or 15,950 tons less than a year earlier. The directors state that the shaft on the adjoining Extended property (which has been purchased for £7,500 by the Grand Junction Co.) has been of great benefit in improving ventilation throughout the present workings, and will facilitate the further developments in contemplation at lower levels in the eastern section of the Grand Junction mine. Moreover, the work so far carried out on the upper levels of the Mary lode has disclosed a body of ore of good width and value. W. McConachie, the mine manager, reports that the labour necessary for rising and winzing was unobtainable at the beginning of the year 1920 except at prohibitive prices.

Ropp Tin.—This Nigerian alluvial tin mining company largely increased its output last year, from 839 to 1,028 tons, and the directors report a profit of £55,147, which compares with £52,150, for 1918. The interim dividend absorbed £33,600 and the final dividend £16,800, making a total of £50,400, as against £41,250 distributed in respect of 1918. Arthur E. Pettit (for the Consolidated Goldfields, the consulting and superintending engineers) gives in his report the ore reserves at the end of December last as 11,000 tons. Very little prospecting was done last year. The output for the first four months of this year—305 tons—shows a falling off due to shortage of rain and the employment of the dredges part of the time in the treatment of tailings, but it is hoped that with the installation of the new hydraulic plants this deficiency will be made up.

Naraguta Extended.—This Nigerian alluvial tin-mining company earned a slightly smaller profit last year, its output of concentrate having been 276 tons, as compared with 280 tons for 1918 and 334 tons for 1917. The product sold realized £167 per ton, or £1 per ton more than in 1918. The profit was £15,318 (against £16,074), and a dividend of 10% (against 12½%) has been paid. A balance of £28,582 (against £18,957) has been carried forward, subject to claims for income tax and excess profits duty. The directors state that further prospecting on the company's areas has proved a total fresh tin reserve of 1,700 tons apart from the tin in the present river bed. In February last the company took up additional areas under prospecting licences, and these are to be prospected as soon as possible. R. W. Hannam, the consulting engineer in Nigeria, reports that, provided there is a sufficiency of labour, the output can be considerably increased.

Tronoh.—Increased working costs and lower metal prices had the effect of reducing the profits of this successful F.M.S. tin-mining company last year. The output at 1,410 tons was 43 tons more than in 1918, but this increase was more than counter-balanced by the rise in expenses from 37·6 cents to 45·6 cents per cubic yard, and the decline in the average price realized for the concentrate from £177 to £146 per ton. The year's profit was £70,904 (as compared with £106,530), and cash dividends of 6s. per share, absorbing £52,000, have been paid, and in addition a share bonus of 25%. For 1918 the distributions totalled 10s. per share. J. H. Rich, the general manager, states in his annual report that No. 3 mine has now attained a depth of between 130 and 140 ft., and with depth the difficulties of extracting the ore at a profit become considerably greater, sand brought down by the springs of water and rain being the chief troubles. Toward the close of the year poorer patches of ground were encountered by both the dredges, and the manager considers it very doubtful if the output from these dredges for the present year will exceed those of the period under review; at the same time he expresses the opinion that there is very little hope of reducing working costs while the labour scarcity, the adverse rate of exchange, the rice shortage, and the difficulty of obtaining firewood continue to prevail. The pontoon of the new dredge for No. 6 area was launched in February last, but it will probably be the end of the present year before this dredge is in commission.

Sungei Besi.—At this mine, in which the Tronoh has a share interest, there was an increase in production last year, although the quantity of ground treated was 8,305 cubic yards less than in 1918. This increase—which amounted to 18 tons, the total output being 423 tons of ore—was due to an improvement in grade from 4·5 lb. to 4·9 lb. per cubic yard. The average price realized was £151 (against £178), and working costs averaged $1·45 per cubic yard, or 13·2 cents more than in the previous year. The profit amounted to £20,625 or nearly £10,000 less than before, but the dividend rate was maintained at 10%, absorbing £11,140. Since the close of 1919 a further dividend of 1s. per share (5%) has been paid. G. W. Simms, the general manager, in his annual report, writes that by the acquisition of the land adjoining on the north it will now be possible to work the company's property to better advantage, "which fact must be put against the other factors affecting the cost of production." A sub-lease over the Kepong mines has also been acquired by the Sungei Besi company; regarding this property the manager remarks that the possibilites lie along the contact between the granite and the limestone.

Idris Hydraulic Tin.—This company is a member of the same group of F.M.S. alluvial tin undertakings to which the Tronoh and Sungei Besi, noticed above, belong, and it also has C. V. Thomas as chairman. Not only did the Idris win a much larger quantity of tin concentrate during 1919, but it also rejoined the dividend list, from which it was absent in 1918. The output was 244¾ tons as compared with 124¾ tons for the preceding year, but the average price realized was nearly £30 per ton less than before. However, after providing for depreciation, there was a profit of £12,571 (against a loss of £3,073 for 1918) and a dividend of 6d. per share was paid at the end of October last, absorbing £3,000, while since the end of 1919 a further distribution of 1s. per share has been made. Osborne & Chappel, the general managers, are of opinion that the present standard of returns will be maintained during the ensuing year.

Ipoh Tin Dredging.—This F.M.S. alluvial tin-mining company produced less tin ore last year, 169 tons against 246 tons in 1918. The yardage treated was 666,700, or 31,880 more than in the previous year; the area worked was 10·05 acres (against 9·46 acres); and the average depth 41·12 ft. (against 41·59 ft.). L. G. Attenborough, the manager, states that the recovery fell as it was found that the value of the ground at the northern end of the property was less than the bores had led the management to expect; and also as this ground had been more recently worked, the Chinese miners, having worked to a greater depth, had taken out the bulk of the tin from all but the most clayey portion. In consequence of the greater proportion of the tin being in the clay, the recovery was low, as the dredge, owing to the designed water pressure in the screen being too low, is not well adapted to breaking up clay. So as to increase the pressure in the screen, alterations to the pumping arrangements have been put in hand. The profit and loss account for 1919 shows a net profit of £662, after allowing for taxes (£3,024), and depreciation (£3,792), but including a claim for refund of £4,313 excess profits duty. Since the close of the year the company's property had been increased by the acquisition of about 143 acres at Kamunting, and the manager refers to arrangements having been made to install two further dredges.

Siamese Tin.—The three dredges at the Ngow mine of this Siamese alluvial tin mining company dealt with a larger quantity of ground last year—1,854,200 cubic yards against 1,656,900 cubic yards in 1918—and 878 tons of ore were won, against 777 tons. Two of the three dredges were working in higher grade ground than in the previous year. The tin ore won by the dredges realized $1,318,607, of which the Government royalty absorbed $206,269. The sale of accumulated tailings yielded $19,039, and the total gross working profit was $568,229. After writing off £7,841 for depreciation, the net profit for the year was £34,159, as compared with £35,652 for 1918, and the dividend rate has been maintained at 25%, absorbing £30,000. John M. Milne, the acting general manager, reports that the Bandon mine showed a fair profit for the first few months of the past year, but at the end of May this mine was flooded owing to the breakdown of the pumping plant, and subsequently all work was finally suspended. The future working of this property is the subject of investigation. The Merah mine produced only 31 tons of tin ore from April, 1919, and showed a loss on the year's operations. Three areas in the Takuapa district were check-bored and leases were applied for.

Mountain Copper.—This company was floated by C. W. Fielding in 1896 for the purpose of working the Mountain copper mines in Shasta County, California. For some years the output of copper was large, but afterward it was found that the reserves of copper ore were limited, and attention was then turned to the great quantities of pyritic ore, high in sulphur and low in copper, for the production of sulphuric acid and phosphate fertilizers, as well as copper. The company was reconstructed in 1902, the shares being converted into redeemable debentures. The report for 1919 shows that 138,196 tons of ore was extracted from the Hornet mine, and about 6,000 tons from the other mines. Concentration and smelting were suspended in April, 1919, owing to the difficulty of marketing copper, and the output of copper was only 1,054 tons. On the other hand the pyrites, acid, and phosphate businesses were supported by a good demand. A new concentrator using flotation has been built, and the leaching plant for saving copper from pyrites cinder has been extended. The accounts for the year show a gross profit of £6,861, but £31,250 has been paid as debenture interest, out of the balance brought forward from the previous year. The company is also hit by the three-year average of income tax, and a heavy claim will have to be met next January. In order to conserve funds until such time as it may be possible to resume copper smelting, the payment of debenture interest was suspended last November.

St. John del Rey.—Although this famous old Brazilian mining company, originally formed in 1830, derived £61,635 from the gold premium in the financial year ended February 29 last, the advantage of this was almost entirely nullified by the rise in the Brazilian exchange. The directors' report shows that 166,000 tons of ore was milled in the period and produced gold valued at £445,028 (at par) and £7,549 of silver. As compared with the average monthly output of 15,400 tons for the five years 1914-18, last year's average, like that of 1918-19, was low, and the decline is attributed to the delay, caused by the war, in the delivery of the plant necessary for cooling the mine, the heat at the lower horizons seriously affecting the efficiency of the mine force. Other contributory causes were the loss of many old and experienced miners during the influenza epidemic of November, 1918, and the continued flattening of the lode, which renders necessary a new system of development. Working costs were considerably higher at 44s. per ton, due to increased wages, prices for materials, and the rise in exchange. The profit for 1919-20, including the gold premium, was £108,605, which compares with £124,338 for the preceding year. Excess profits duty amounting to £32,269 has been refunded. On the ordinary shares a dividend of 10% has been declared, the same as for several preceding years. George Chalmers, the superintendent, in the course of his lengthy annual report, expresses regret that in spite of an increased native labour force the output has not shown a greater increase, and foreshadows a great improvement when the cooling plant is in operation, as, he says, from investigations made in England and other countries, it would appear that the Morro Velho miners are working at a temperature considerably above what is supposed to be the maximum at which anything like efficiency can be obtained. About nine pages of his report are devoted to a description and discussion of the final scheme evolved for the more economical and rapid development of the lode below horizon 22. Briefly, it is proposed to develop the mine by means of inclined shafts instead of vertical shafts and horizontal tunnels, the change being rendered expedient because the lode which originally pitched at an angle of 40° has been gradually flattening until it has reached an angle of about 19° at horizon 21. The superintendent writes that the sooner the new system can be put into operation the sooner the mine will be producing 16,500 tons per month on economical lines. As regards the lode continuing in depth as at present as regards the size and quality, there is very little indication to the contrary at horizon 21, where in both respects the lode appears to compare favourably with many of the proved horizons above. The directors mention that the cooling plant is now erected, and is expected to be running in a few months' time, when the plant for supplying the necessary power is available.

Ouro Preto Gold Mines of Brazil.—The gold premium has made a considerable difference to this company, which owns the old Passagem mine in the province of Minas Geraes, Brazil. The report for 1919 shows that 81,500 tons of ore was crushed for a yield of 28,232 oz. of gold and 660 oz. silver, equal to a yield of 29s. 4¾d. per ton taking the par value of the produce. In 1918 the tonnage milled was 63,400, and the yield was 28s. 6d. The gold premium secured in the last five months of the past year, however, amounted to approximately £11,370 and raised the average yield to 32s. 2½d. Working costs were 2s. more at 29s. 9½d. per ton, the rise being due to the higher rate of Brazilian exchange and to increases in the cost of labour and materials. The accounts show a profit of

£8,835, which compares with only £1,223 for 1918. Expenditure on machinery and depreciation, amounting together to £3,852, have been written off, £1,000 has been added to the reserve fund, and £1,221 divided among the preference shareholders, this distribution being equal to 10%. In February last 14,949 of the unissued preference shares were subscribed for, and the directors have consequently given notice that the debentures issued in 1919 will be redeemed. The mine superintendent estimated the ore reserves at the end of last year at 81,523 tons, or 351 tons less than at the end of 1918. He writes in his report that it was not possible last year to carry out as large a programme of development as projected, but every effort is now being made to show substantial improvement in this respect. The ore deposits in the 920 metre level S.W. have improved as regards productiveness, and the value of the mineral recovered from them has been above the normal. While on the one hand he describes the prospects of the mine as encouraging, mainly by reason of the improvement in depth, on the other hand he records a persistent demand for increased wages, and states that it has been, and continues to be, difficult to maintain an adequate number of good workmen. The company has arranged with a Brazilian group to provide the cost of driving an adit level to drain the old Maquiné mine, in consideration of which they will receive a half interest in the property. This work was commenced last December.

Poderosa.—This Chilean copper proposition produced a much smaller quantity of ore last year (1,498 tons against 3,309 tons), shipments having been curtailed after February on account of the unremunerative level to which the price of the metal declined after the removal of all restrictions by the American Government in December, 1918. In August, conditions having improved, production was gradually increased, but it did not reach normal proportions until the last month of the year. The accounts for 1919 show a debit balance of £1,599. After providing for depreciation of investments and income tax, this debit balance has been increased to £21,977 by writing off £12,169 for mine development, £3,208 for depreciation of plant, and £5,000 in respect of expenditure on the Bolivian property, the option on which the directors have decided not to exercise. J. H. Ivey, the general manager, states that it is not possible to give a close approximation of the ore now available in the company's mines, but it is anticipated that above Level 8 south in the San Carlos shoot there is sufficient to maintain an output of not less than 400 tons of 27% ore for the year 1920. Below Level 8, this shoot and the smaller shoot on the Poderosa side were being developed on Level 9 at the date of his report, but in neither case had payable ore then been reached.

Esperanza.—The original mine in Mexico of the American-formed Esperanza Mining Company, of which Esperanza, Ltd.—the British company—holds almost all the share capital, is nearing the end of a very profitable career. Last year 267,258 short tons consisting of ore, fills, and sand tailings, were treated for a yield of $1,497,459 and miscellaneous receipts brought the total revenue up to $1,524,432 against expenditure (including depreciation) which amounted to $1,483,264. The profit of the British company was £6,611 (against £25,127 for 1918). The general manager states that there is very little high-grade ore left in the mine, and its future life depends upon the successful treatment of the lower-grade material remaining. In order to increase the tonnage basis considerable changes in the crushing and treatment plant have been effected, the whole cost of which has been charged monthly against revenue. With regard to the Union en Cuale property in the State of Jalisco, under option to the Esperanza company, it is stated that active exploration work is being carried out. The old stopes in one or two of the mines have been reached. M. H. Loveman, under whom the geological conditions obtaining at the Bawdwin mine of the Burma Corporation were investigated, has been engaged for some months in making a geological report on the Union en Cuale property. There appears to be much similarity in the features of the two deposits. A diamond-drill started running in April.

Buena Tierra.—Although at this Mexican mine ore production was in progress throughout the past year, whereas in 1918 shipments were made for only eight months, the accounts for 1919 show a loss of £11,507, which compares with a profit of £7,373 for 1918. The tonnage shipped last year was 9,066 (against 13,063 in the previous year) and the net smelter return therefrom was $97,587, but the mine costs, including $69,724 for development, amounted to $143,610, or $15·40 per ton, and there were other expenses of 33 cents per ton, making the total $15·73 per ton. A. C. Brinker, the general manager, reports that owing to the lack of compressed air and the slow progress by hand-work, it was not possible last year to carry on the necessary development work to increase the tonnage from the ore-bodies. A new compressor has since been installed, and developments on an extended scale are being carried out. These have recently been supplemented by diamond-drilling.

Libiola Copper.—This company has worked a copper mine in northern Italy since 1867. T. V. Anthony, of Henry Bath & Son, is the chairman. The report for 1919 shows that labour troubles have greatly interfered with operations, The strike, mentioned in last year's report, terminated in July, and work was gradually resumed thereafter, until by the end of the year the monthly production had risen to about half normal. The output of copper ore during the year was 436 tons and of pyrites 2,964 tons. Transport difficulties were so great that not even this limited output could be forwarded to buyers with any regularity. The reserve at December 31 was estimated at 5,785 tons of copper ore and 35,560 tons of pyrites. No exploration has been done lately owing to scarcity of labour. The demand for copper ore is poor and the company's stocks are accumulating. On the other hand the price of pyrites has strengthened and has compensated to a material extent for the heavy increase in working costs. The company's account shows a loss of £3,696 on the year.

Esperanza Copper & Sulphur.—Only very small profits have been made the last two years by this company, which took over in 1906 a group of copper and sulphur mines in the Huelva district of Spain. No dividend has been paid since August, 1918, when 5% was paid in respect of the preceding year. For 1918 the profit was £4,761 and for last year £2,039. The directors state that the mine was shut down for the first six months of the past year owing to lack of shipments. The ore reserves at the end of the year were estimated at 882,000 tons.

Village Main Reef.—The report of this company for the year 1919 shows that 218,900 tons was melted, being a fall of 46,800 tons as compared with the year before. The net profit was £21,102. The dividend declared absorbed £47,200, being at the rate 2s. per share. The ore reserve, including shaft-pillars, was estimated at December 21 at 284,180 tons averaging 6·3 dwt. gold per ton. As no more ground remains to be developed, it is obvious that operations will soon cease. As recorded last year, 118,000 shares in Village Deep were distributed among shareholders.

The Mining Magazine

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PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LIMITED AND REDUCED, AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938.* Telegraphic Address: *Oligoclase.* Codes: *McNeill,* both Editions.

BRANCH OFFICES: 420, Market Street, San Francisco. 300, Fisher Bdg., Chicago. 2,222, Equitable Building, New York.

SUBSCRIPTION 16s. per annum (Single Copy 1s. 6d.) including postage to any part of the World.

Vol. XXIII. No. 2. LONDON, AUGUST, 1920. PRICE 1s. 6d.

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EDITORIAL

WE have received a copy of the Register of the Associates and Old Students of the Royal School of Mines, with which is bound a History of the Royal School of Mines. Owing to shortness of space at our disposal we are obliged to postpone an adequate notice until next month. In the meantime we record that the volume is sold at the Bookstall of the Imperial College Union, Prince Consort Road, South Kensington, and that the price is 15s. to members of the Old Students' Association and 20s. to others, in both cases post free.

IN spite of much adverse criticism, coming from all quarters, the Government has persisted with the Ministry of Mines Bill, and the third reading was carried in the House of Commons on July 29 by a majority of 129 votes to 35. The final debate received little attention at the hands of the parliamentary reporters, and consequently the average newspaper reader was not aware of its passage. Representatives of the Miners Federation have plainly stated that there are clauses in the Bill which they cannot possibly accept, while all societies and individuals interested in non-ferrous metal mining have expressed their dissatisfaction that this branch of mining receives no recognition whatever. The discussion of the Bill in the House of Lords was fairly lively and, on one minor point, the Government was defeated, but it is probable that the Bill will have been forced through Parliament before this paragraph appears in print.

A book on Mr. H. C. Hoover and his work, published by Appletons, of New York, and written by a Mr. Vernon Kellogg, contains the following account of Mr. Hoover's activities at Broken Hill: "His work took him back to Australia, the land of his first notable success, but this time into South Australia, instead of West Australia. Here he took personal charge of a large constructive undertaking in connection with the rehabilitation of the famous Broken Hill mines. These mines were in the inhospitable wastes of the Great Stony Desert, four or five hundred miles north of Adelaide, the port city. The living and working conditions on the desert were a little worse than awful, but by his technical and organizing ability he brought to life the two or three abandoned mines that constituted the Broken Hill properties, and adding to them some adjoining lower-grade mines, converted the whole group from a state of great unrealized possibilities into one of highly profitable actualities." This account reminds us of the schoolboy's definition of a crab as a "red fish that walks backward." Except for the fact that it is not a fish, is not red, and does not walk backward, it was quite a good definition.

MANY organizations in America connected with fire extinction recommend the use of "flammable" instead of "inflammable," owing to the meaning of the latter word being so often misunderstood by those with defective education. These societies certainly have a just grievance against the old word-creators, who gave the prefix "in-" two entirely different meanings. Greater trouble, would, however, arise if there were two sets of meanings to a dangerous word of this sort. The societies concerned may be advised alternatively to give the dictionary meaning of the word "inflammable" on all their printed rules and instructions.

SOME years ago there was a discussion in the technical press with regard to the inconvenient size and weight of scientific books, the point being that travellers are precluded, for this reason, from taking an adequate reference library on their journeys, or for their use during a lengthy sojourn abroad. This question crops up again with the present cost and scarcity of paper. Substantial economies could be secured by using a thinner paper, and employing narrower margins and a smaller type. Possibly what could not be done for purchasers' convenience before can now be done for economy for the benefit of the publishers. With regard to margins and size of type another question arises. Would it not be possible, when issuing notices of new books, for the publisher to give details as to the size of the actual page of type, of the spacing between lines, and of the denomination of type? On perhaps it would be preferable to give the number of pages and the number of words on each page. While writing this note we have before us a book written by an eminent scientist and favourably reviewed in authoritative journals. It is advertised as being octavo in size and containing 221 pages. The size of the paper constituting the page is 8½ in. by 5½ in., but the space covered by the type is only $5\frac{1}{4}$ in. by 3 in., and the type is pica, with the lines liberally spaced. The paper is so stout that the thickness of the book is $1\frac{3}{4}$ in. Thus the book, though bulky, contains a very small total of reading matter, far short of the desires and requirements of the earnest student, and is correspondingly disappointing to the buyer. This, of course, may be an exceptional case, but it forms an excellent example whereby to urge the argument that more exact information should be given of new books by the publishers and that less paper should be thrown to waste.

Mining in Ontario.

In this issue is published an article by Dr. J. Mackintosh Bell on the nickel-mining industry of Sudbury, Ontario. In the September issue this will be followed by another article from his pen dealing with Porcupine. These articles are based on lectures delivered by the author earlier in the year at Harvard University. We hope to be able to publish in subsequent issues other articles drawing attention to the importance of Ontario as a metal-producing province. It may be objected that there is little new to be said about the Sudbury district. On the other hand, many readers who rely on the files of the Magazine for their information will be glad to have Dr. Bell's concise account of this important mining centre. Dr. Bell, in lecturing before Harvard, also devoted one of his addresses to Cobalt. For two reasons we shall not reproduce this lecture in our pages; firstly, an article by Dr. Bell on this district was published in the Magazine for February, 1914, and, secondly, a new geological survey is being made of the district by Mr. C. W. Knight for the Ontario Bureau of Mines, and his report will form the basis of an article. The decision to have a new survey of Cobalt was prompted by the change in the position of the silver market. It is clear that, with silver double the price it used to be, taken together with the many metallurgical improvements of recent years, the problem of payability is put in quite another light. It is probable, therefore, that Mr. Knight's examination will lead to important accessions of mining ground.

It is claimed by many, and perhaps rightly, that at the present time Ontario presents better opportunities for prospecting for metals than any other accessible part of the earth's surface. While not going so far as to adopt this optimistic view in its entirety, we may safely express our wonder that English financial houses have not done more in a part of the British Empire so near to our doors. At the present time the Mond Nickel Company and the British America Nickel Corporation are the two English companies that conduct the biggest mining operations in Ontario. The Associated Gold Mines of West Australia has developed the Keeley silver mines near Cobalt, the Kirkland Lake Proprietary has interests in the gold-mining district of that name, and there is a market here for the shares of the Mining Corporation of Canada, which owns expiring properties at Cobalt. Just recently English participation in the development of the Davidson claims has been secured by the Canadian owners. In spite of vigorous attempts in the early days, English interests in Porcupine are very small. It is commonly said that the Whitaker Wright vagaries in British Columbia left a settled prejudice against Canada in the minds of those who can influence capital in London. Probably the want of success of the Mikado gold mine in the Lake of the Woods district also had something to do with the unpopularity of Ontario. More recently, too, the misadventures of the Kirkland Lake Proprietary have afforded causes of discouragement. In spite of these unfortunate episodes, it can confidently be said that Ontario deserves closer attention than it receives on this side. Those who have read the regular letters in the Magazine from a Toronto correspondent will appreciate the amount of solid work done at the various mining centres in Ontario, and will have some idea of the chances of developments in these centres and of the probabilities of new discoveries in the Pre-Cambrian terrain of Ontario and Manitoba.

Union Minière du Haut Katanga.

The directors' report for 1919 and the chairman's speech delivered at a meeting of shareholders held at Brussels were of exceptional interest, as they indicated that this great enterprise is now successfully emerging from the long period of disorganization caused by the war. From the information given by the board we learn that during the year 36,000 tons of smelting ore was mined at the Star of the Congo group, 123,000 tons from the Kambove group, and 30,000 tons from the Likasi group, and that the copper produced from this ore was 23,028 tons, a yield corresponding to an extractable content of $12\frac{1}{4}\%$ of copper in the ore. There was also mined 360,000 tons of concentrating ore and 327,000 tons of leaching ore, both being stored for future treatment. A concentrator, having a capacity of

4,000 tons per day, is in course of erection, and it is expected that the first units will be ready to start before the middle of next year. The experimental leaching plant will also probably be completed at about the same time. As regards prospecting and development, the scale of these operations is about to be considerably extended. The power question is being closely studied, particularly in connection with the supply of current for refining purposes, and a party of engineers has gone to Katanga with a view of preparing hydro-electric schemes. Attention is not confined to the copper deposits, for tin deposits have also been developed. The Busanga mine has reached the operating stage, and a production of 50 tons of tin concentrate per month is expected. Prospecting for tin is being actively conducted in the Kasonzo district, where deposits at Kibole and Shiensi are giving encouraging results. The company is faced with difficulties arising from shortage of labour, and the questions of transport and fuel supply still loom large, but these matters will settle themselves in time. It has not been possible to issue a statement of account with the report for 1919, chiefly because the copper, though sold under contract, has not yet been realized. There is one item in the report which gives rise to an unpleasant feeling. We refer to the demand of the British revenue authorities for income tax and excess profits duty. It will be remembered that, on the invasion of Belgium and the threat to Brussels, the Union Minière accepted the hospitality of its friends in London, and during the war shared the offices of Tanganyika Concessions. The tax-collector immediately put in a claim on the ground that the company was trading in England, and after long negotiation the matter was settled on the company agreeing to pay £300,000 in full settlement. No doubt it may be said that business is business and that the company enjoyed the privilege of British protection, but to the philosopher and the cricketer there is something repellent about this action of the revenue authorities. With regard to the future of the company's enterprise, progress will necessarily be slow for the reasons already given, but there is no formidable obstacle to the eventual realization of the company's hopes and expectations.

University Education in London.

A few of our readers, fortunately a very few, have allowed themselves to believe that we are unmindful of the best interests of the Imperial College of Science and Technology and the Royal School of Mines, or even that we are inimical to their progress and development. This is the impression they have received by reading our editorial last month, wherein we recommended these institutions to come wholly under the banner of London University. It is probable that this belief or impression is more fancied than real, and has been aroused largely by disappointment at our attitude; nevertheless, owing to its existence it is desirable to refer to the subject again. It is quite a mistake to suppose that we have any prejudice in the matter. No one has a higher esteem for the staff, associates, and course of study of the Royal School of Mines than we have; our only disagreement is in relation to the policy adopted in seeking university advantages. The Government, other London educational establishments, and the great majority of educationists in this country and abroad are against the Imperial College becoming an independent university, holding that it should be an integral part of the university already in existence. In consideration of this position, why carry on an agitation that appears to have little chance of success? Why not accept the offer already at hand? This offer, from London University, is no mean one. The wonder to us is that those in authority at the Imperial College have not accepted it with avidity long ago. As regards the relative qualities of degrees, everyone knows perfectly well that the London M.A., D.Sc., and M.D. stand out in a class by themselves, and are more highly prized than the degrees of either the old universities or of those more recently established. To our way of thinking, it should be regarded as an inestimable privilege to be offered a participation in such degrees.

An opportunity now arises for a reconsideration of the position of London University and the Imperial College. This opportunity is provided by the prospective remodelling of the teaching functions of the former and the erection of suitable buildings therefor. The Government has offered ground in Bloomsbury, between the British Museum and University College, for these purposes, but the space is cramped and the neighbourhood and surroundings are not conducive to quiet contemplation or concentrated study, and the Senate of the University has accordingly asked for time for consideration. In the meantime Professor Flinders Petrie has made the suggestion that the University should acquire the Kenwood estate lying between Highgate and Hampstead. Those of us who know our London are charmed with this suggestion. For years the future of this beautiful stretch of rolling woodland has been in doubt, causing much anxiety to lovers of nature. It could not be put to better use than to provide a healthy and restful home for a University, and Professor Flinders Petrie's suggestion will accordingly receive a large share of support. The ultimate decision with regard to the locale of the new University buildings has, however, no bearing on the question now under discussion.

Government Extravagance.

The circular letter sent to the press by a number of business men, asking the public to take active steps to stop the extravagant expenditure on the part of the Government and local bodies, deserves the careful consideration of the whole nation. It is not necessary to reproduce it here, for everybody has, no doubt, already read it, but a few supplementary questions may be asked and additional comments made. Is it really necessary to provide dress clothes for the army? Where is the money coming from to build the premises and pay the extra teachers if board-school education is extended for another four years? What is the good of appointing legions of medical inspectors with undefined duties? Why should not the railways be allowed to manage their own affairs? Why should men, or groups of men, who are clever enough to increase their businesses, be reduced to the common level of humanity by being raided by the income-tax man and the collector of excess-profits duty? And so on.

The removal of all these absurdities will only be effected when the principle of nationalization of industries is rejected. The State or other public body should never engage in business if a private person or company is willing to undertake the work. In that way, costs of operation will be greatly reduced, and the wants of the public will be better considered. If the head of an enterprise relies for his profits on his successful work, he will take care to make it pay and at the same time please his customers. On the other hand, the head of a government or parochial "business" department does not have to exercise his wits to make things pay, for he can fall back on the taxes or rates in case of disaster. Nor is it any use calling for a "business government," for the business man who is effective when working on his own responsibility soon degenerates and becomes careless, and in any case he would be blocked by the irremovable staff under him. Whenever a business enterprise is nationalized inefficiency flourishes. The telephone is an example of fatuous incompetence. But for Henniker Heaton, the Post Office would always have been a monument of "it-can't-be-done," and now that he is gone it is rapidly relapsing. The Metropolitan Water Board has not given us a better or cheaper supply than the New River Company. The borough electric light and tramway systems are not such good servants to the public as similar organizations under private control. In addition to the advantage of economy accruing to the community when business enterprises are taken out of the hands of public bodies, there is also the benefit that those in charge of the enterprises are subject to effective criticism and pressure from the public bodies. To put it in colloquial language, it is best altogether that the public body should not undertake these businesses, but see that the other fellows do their duty. The borough councils have other operations under their control which are not sought by the business men, as not being of a profitable nature; for instance, dust and sewage disposal and road paving. But in these cases it is just as necessary to seek economy by cultivating competitive contracts, instead of creating official departments for undertaking the work.

So much for the public spending departments. When the public collecting departments are considered, another problem arises. All the money required for the spenders has to come out of the pockets of somebody else. There is no such thing as the spontaneous creation of funds, no beneficent abstraction welling forth credits. It seems absurd to have to say this; yet as a matter of fact ninety-nine out of every hundred people, including both ordinary folks and Government employees, have an idea that the State can provide such funds without touching the individual. So it has to be reiterated that every pound extracted from the individual causes a corresponding contraction of his spending powers; that every pound collected as excess profit duty restricts expansion of business to that extent, raises the price of money, and causes the manufacturer to increase his prices or depreciate the quality of his goods. Heavy taxation is one of the factors in the so-called vicious circle, the others being scarcity of materials, suppression of competition, and the indolence of the worker. Here it may be said that the application of the logicians' "vicious circle" to the continuous chase of wages and cost of goods is not a particularly happy one. A "vicious spiral" would be a preferable term, in that it involves the recognition of a definite point of origin, and indicates an ever-widening radius at each turn of the whirligig.

It may be objected that the question of public extravagance has nothing to do with mining and metallurgy. A moment's thought, however, will reveal the connection. With trade in a condition of stagnation, the demand for industrial metals will decrease, and with high costs their extraction from the ores will become unprofitable. It is clearly the duty of the mining engineer and everyone connected with mining to fight the forces that cripple the industries of the world.

The Study of British Minerals.

Elsewhere in this issue Mr. J. D. Kendall discusses some aspects of the structural geology of the English Lake District as it affects the distribution of lead, zinc, copper, and iron ores. If the author's theories as to the origin of the ores do not satisfy some of the modern scientific petrologists, they are at any rate based on long observation and intimate knowledge of the ore deposits and they have proved useful in practice. Whether the theories are acceptable or not, the present paper will serve to draw attention to the desirability of making a new geological and petrological survey of many parts of the British Isles where lead, copper, zinc, and iron minerals are known to exist. During the war inquiry was made into the kingdom's resources as regards these minerals by a number of our leading mining engineers on behalf of the Ministry of Munitions, but the object was rather to seek immediate supplies at any cost than to study the subject from the scientific standpoint. The fact that Dr. J. S. Flett has recently been appointed director of the Geological Survey points to the possibility that the non-ferrous metals will receive closer attention than in the past. Cornwall has been covered fairly well by the Survey, though the ore deposits have not as a rule been treated from the point of view of the mining man and the structural geology has not always been based on underground observations. Derbyshire and Flint have formed the subjects of Memoirs, and Clifton Ward wrote one on the Lake District in 1875. With the exception of the Flint deposits the Welsh resources of non-ferrous ores have been neglected by the Survey. Sir Andrew Ramsay's great volume on the geology of North Wales entirely ignores the metals; in fact the word "ore" does not occur once. Other parts of the British Isles have received just as scant attention. The best modern scientific study of British lead and zinc deposits was done about ten years ago by the late Dr. A. M. Finlayson. His contributions on the paragenesis of these minerals to the *Quarterly Journal of the Geological Society* and to *Economic Geology* showed great insight, and his untimely death in the war robbed geological science of a promising pupil. His work in this connection was in the nature of a holiday task, and this feature of his method, if adopted in other quarters, would go far to solve the oppressive question of cost. It is usually said that public money would be well invested if applied liberally to the purposes of the Geological Survey. But nowadays there is no chance of such funds being forthcoming, and unless Dr. Flett can make his present allowances cover the cost of the new work, reliance must be placed on the amateur or on the professional geologist who takes the work as a holiday task.

With regard to Mr. Kendall's theory of the origin of these ores, we note that he ignores the existence of magmatic waters and attributes the formation of metalliferous solutions to the contact of magmatic emanations with circulating meteoric waters. It is so much the fashion nowadays to suppose that these metalliferous solutions are part of a residual mother liquor that, as we have said, many modern petrologists will be inclined to give Mr. Kendall less than his due. For ourselves we confess we have never been particularly convinced as to the validity of the magmatic water theory. The fact that mica contains an atom of hydrogen does not outweigh the existence of a critical point for water. The theory vaguely mentions water as a terminal product, but this does not really elucidate matters. Water would have to exist in some entirely different form from that with which we are acquainted before it could assume the functions of a magmatic mother liquor. In the absence of knowledge of any such form of existence it is permissible to give Mr. Kendall's view every consideration.

Another interesting point in connection with Mr. Kendall's theory is that which relates to the solubility of certain metals in each other. Mr. W. H. Emmons has drawn attention to the solubility of silver in other metals as affecting the question of its occurrence in association with lead and copper, but Mr. Kendall's note is of wider significance, for, in conjunction with his magmatic theory, it goes far to explain the existence of so many deposits of complex and intimately mixed sulphides. His idea is worthy of development in greater detail.

REVIEW OF MINING

Introductory.—The fear of further conflagrations arising from the power of Bolshevik Russia, and also the threatened development of revolution in Ireland, are combining to cause a set-back in new business. Dearer money and the renewed fall in American exchange are also adverse features of the situation. The manufacturers are making an endeavour to induce the Government to reduce the forces of bureaucracy and to put a severe restriction on public expenditure. For the next month or two, however, we may expect the usual seasonal relaxation in business, and no new active move can be undertaken until October. As regards the metal market, it will be observed from the tables in our statistical pages that the prices of gold, silver, and tin are slowly creeping up again. It is supposed by those who usually know something of the intimate dealings among speculators that arrangements have been made for another advance in tin, but we cannot vouch for the correctness of this surmise.

Transvaal.—The Rand is troubled by a new labour demand. This time the enginemen at the mines are threatening to strike unless their demand for double pay for Sunday work is granted. This point has been under argument for some time, and the Chamber of Mines has consistently refused an advance.

The property of Randfontein Deep is to be acquired by Randfontein Central in exchange for 250,459 new £1 shares in the latter company. The Deep company when first formed worked the Battery Reef, but ten years ago started two vertical shafts in the hope of cutting the Randfontein Reef in depth. These were sunk to 2,083 ft. and 1,650 ft., and then the funds gave out. The operations of Randfontein Central have been upset by the collapse of the old Robinson shaft, and the output will be affected until the new north vertical shaft comes into commission in October.

At Modderfontein B the new 200 drill compressor started in June, and by its means it will be possible to substantially increase the output of ore.

The Daggafontein company announces that No. 2 shaft reached the reef on August 3 at a depth of 3,948 ft. At the point of intersection the reef averages 26·1 dwt. over 14·5 in. The company is requiring further working capital.

The Sub-Nigel company, operating in the Heidelberg district, reports that in the 21st level, west from the new vertical shaft, the ore averages 19 dwt. per ton over a width of 42 in.

Rhodesia.—An abstract of the yearly report of Rhodesia Broken Hill is given elsewhere in this issue, and a report is also given of the speech of the chairman, Mr. Edmund Davis, at the meeting of shareholders. It is gratifying to be able to record that a net profit of £100,889 was made, out of which the first dividend, absorbing £35,000, or 10%, will be paid. Presumably out of the balance a heavy claim for excess profits duty will have to be met.

The metallurgical plant at the Cam & Motor has been reorganized, dry-crushing and roasting being eliminated and wet-crushing and flotation substituted. It is expected that the plant will be re-started in October on a basis of 15,000 tons per month.

Central Africa.—Orders in Council have been issued to the effect that in future German East Africa is to be known as Tanganyika Territory, and British East Africa as Kenya Territory.

West Africa.—The latest progress report from Prestea Block A shows that a cross-cut to the lode on the 12th level passed through 160 in. of ore averaging 11·9 dwt. Two previous cross-cuts had shown ore averaging 10 dwt. over 236 in. and 11·9 dwt. over 207 in. The lode has now been developed for 629 ft. from the shaft on this level, and the average assay-value is 9·8 dwt. over 127 in. This body of ore is probably a new lens first found on the level above, where its length was 270 ft. averaging 9·5 dwt. over 122 in. These results appear at first sight to be good, but unfortunately the ore is refractory and the cost high, so that there is little or no margin of profit.

Owing to difficulties with the Inland Revenue authorities, the directors of Fanti Consolidated have decided to abandon the flotation of a subsidiary company to handle the manganese deposits in West Africa, and the development will be done by the company itself. For this purpose 128,880 shares of the nominal value of 8s. are to be issued at 16s. The company has made a contract for the delivery of 100,000 tons of manganese ore per year for a period of five years, renewable for two further terms of five years. The contract is arranged in such a manner that the company is guaranteed a minimum profit of 7s. 6d. per ton.

Nigeria.—The market has been considerably disconcerted by the announcement that Tin Areas of Nigeria is about to issue

£250,000 convertible debentures. This company, when under the direction of the late Mr. Assheton Leaver, did a substantial business in Nigeria, and was gradually extending its many trade ramifications, the tin business becoming a comparatively unimportant item in the programme. Last year the capital was increased by the issue of 1,200,000 new 5s. shares at 7s. each, and plans were laid for changing the name of the company to the British West African Corporation. The cause of this sudden change in the financial position can only be surmised to be over-trading at a time when the prices of products are slumping.

Announcement is made that Wardens of Mining Districts are to be appointed in Nigeria, with duties akin to those in Australia. This arrangement will greatly facilitate official mining business and should help in establishing a settled policy with regard to labour. Particulars of this new move are awaited with interest.

Australasia.—There is now more hope for a resumption of work at Broken Hill, for the miners' delegates have agreed to a joint conference under the chairmanship of a nominee of the Governments of the Commonwealth and New South Wales.

A cabled summary of the report of the Mount Morgan Gold Mining Co. for the year ended May 30 states that 294,485 tons of ore was mined, of which 175,658 tons went to the concentrator, where 67,836 tons of concentrate was produced, while the remainder went direct to the smelter. At the smelter there was treated 110,699 tons of ore and 58,150 tons of concentrate, for a yield of 5,880 tons of copper and 80,578 oz. gold. At the close of the period under review 4,432 tons of copper was unsold or in course of refining. The dividends distributed absorbed £150,000, being at the rate of 15%. Experiments in connection with roasting and leaching have been discontinued, as it was found that the capital outlay on plant would not be warranted by the savings promised.

The Mount Lyell Mining & Railway Co. has sold its control of the Mount Read & Rosebery Mines company to the Electrolytic Zinc Company of Australia. This policy has been adopted owing to the many difficulties in the way of erecting a metallurgical plant to treat the ores. It was originally intended to start works on much the same lines as those belonging to the Electrolytic company near Hobart, Tasmania, but the greatly increased cost of such a plant and the difficulty of raising the necessary capital have prevented the scheme coming to fruition. The Electrolytic company is to increase its capital from £1,000,000 to £2,500,000, divided into equal amounts of ordinary and preference shares, and 1,050,000 of the latter are to be issued to provide further working capital. The terms of sale of the Mount Read & Rosebery property are the issue of 350,000 of the new ordinary shares and the right to subscribe at par for 150,000 preference shares. Particulars of these mines were given in the Magazine for February, 1919.

A few months ago South Kalgurli Consolidated announced a great improvement in the results of development. Since then a large amount of high-grade ore has been disclosed on the 15th level. Exploratory work is to be conducted with a view of testing the continuity of the lens in both upward and downward directions.

The Kalgurli company announces that it has sent an engineer to South America to inspect dredging properties on which an option has been obtained.

Malaya.—Last May we mentioned that there had been an extraordinary boom in Melbourne in shares in the Badak Syndicate, which reported high results of boring at Jenari, in the State of Kedah. News is now published of the results of independent bores. It is stated that not one of eighty holes has given satisfactory results. The vendor has taken up the challenge and says he is prepared to go back to the property and investigate. In the meantime the £10 shares, which had boomed to £2,000, are now quoted at 1s. 2d.

India.—As announced recently, it has been proposed that the Bawdwin lead-zinc-copper-silver mines in Burma should be transferred to a new company called the Burma Corporation, Ltd., registered at Rangoon. The capital of this company is 20,000,000 shares of 10 rupees each, and of these shares 13,541,682 would be issued to Burma Mines, Ltd., as purchase price. Burma Mines, Ltd. (an English company), has 967,263 issued shares of £1 each, of which the English company, Burma Corporation, Ltd., holds 964,499, which is also the figure representing its own issued capital. The scheme provides that the English Burma Corporation shall go into liquidation and distribute its holding in Burma Mines among its own shareholders, and that Burma Mines should subsequently liquidate and distribute shares in the Indian Burma Corporation among its own shareholders. The new Burma Corporation is to issue £1,000,000 8% convertible debentures for the purpose of providing funds for extending and completing the plant, thus freeing future profits for dividend purposes. The subscription of the whole of the issue has been guaranteed by the National Mining Corporation, for whom Mr. J. A. Agnew has made a comprehensive report on the Bawdwin enterprise. As we gave an outline of the concentration problem in December, 1918, and of the metallurgical programme in November, 1919, we need not review Mr. Agnew's report here. The reserves, proved and probable to a depth 100 ft. below the lowest level, at December 31 last are calculated as follows: High-grade lead-zinc ore, 4,157,462 tons averaging 26·7% lead, 18·8% zinc, 0·4% copper, and 23·9 oz. silver per ton; high-grade ore high in copper, 335,681 tons averaging 12·8% lead, 7·7% zinc, 11% copper, and 23·1 oz. silver; low-grade ore in the Chinaman ore-body, 1,600,000 tons averaging 7·5% lead, 4·8% zinc, 0·2% copper, and 5·1 oz. silver; low-grade gossan, 1,600,00 tons averaging 5% lead and 5 oz. silver. This ore is sufficient to last for ten years at the intended rate of extraction. A 200 ft. possible extension of the high-grade lead-zinc ore-bodies would give 974,000 tons taken at 28% lead, 14% zinc, 1% copper, and 24 oz. silver. As regards depth, the geologists say they expect that when the rhyolite country-rock gives way to sedimentaries the width of the ore will become much less and the lode will become of the ordinary fissure type. Judging by information available relating to pitch and faulting, the sedimentaries are not likely to be reached as soon as was at one time expected. At the meeting of shareholders of the English Burma Corporation, called to sanction the liquidation, Mr. R. Tilden Smith raised considerable opposition. He demanded a poll, the result of which will not be declared until the 23rd inst. Mr. Tilden Smith was one of the original developers of the Bawdwin property, and has always held or controlled large blocks of shares. The poll will disclose the extent of his following, a mystery to everybody outside the board-room. It is quite possible that the result of the poll may upset the plans outlined above.

The Ooregum mine is in the fortunate position of being able to supply funds for additional capital expenditure out of its own ore reserves without at the same time reducing its rate of dividend. It is estimated that £40,000 will be required during the current year for continuing the sinking of the deep vertical shaft, and £30,000 for providing an internal electric hoist, air-compressor, ventilating fan, etc. Owing to the greatly increased assay-values in Oakley's section, to which attention was drawn in the yearly report published in May, it is possible to extract richer ore and to increase the monthly output by 800 oz., beginning in July.

After being out of the dividend list for a dozen years, the Balaghat has once more resumed distributions, the amount being at the rate of 10% on the 95,400 preference shares of 10s. each.

Cornwall.—As mentioned last month, a committee of shareholders was formed for the purpose of investigating the position of things at Calloose. Three members of this committee were deputed to visit the properties, and they called in an independent Cornish mining engineer to advise them. We are informed that the reports made by these gentlemen, as a result of their investigations, are quite unprintable. We quite believe it. As James Fawn used to sing:

There ain't a word, not a naughty word,
That's strong enough to suit me, don't you know;
But I give you my word,
That if there was a word,
'Twould be a treat to hear me let it go.

The lines don't scan and the grammar and construction are shocking, but the verse is good enough for Calloose.

In February, mention was made of the flotation of the Kingsdown (Hewas Water) Tin Mines, Ltd., formed to reopen shallow mines south-west of St. Austell. Developments have been continued steadily. The main shaft has been sunk to 203 ft., and driving has been done along two lodes, at depths of 150 ft. and 120 ft. respectively. At the former the width is 2 ft., and ore averaging 50 to 60 lb. of black tin per ton has been raised; at the latter the lode is 4 ft. wide and averages 35 lb. Cross-cutting is in hand to intersect two other lodes. The Ventonwyn property adjoining has been acquired on option; this is believed to contain continuations of the Kingsdown lodes in addition to the known lodes. Messrs. Pawle & Brelick are the consulting engineers.

The Royal Cornwall Polytechnic Society is to hold its seventy-fourth exhibition at the Public Rooms Building, Camborne, from the 14th to the 18th of September. Communications with regard to space, etc., should be addressed to the secretary, Mr. E. W. Newton, Pendarves Road, Camborne. Naturally the exhibits will be very largely devoted to mining, metallurgy, and general engineering.

British Oil.—English Oilfields, Ltd., which is exploiting the oil-shales of Norfolk, has issued a circular intended to combat "the various rumours current to the disadvantage of the company," which the directors say "must have emanated from persons at one time in the company's employ." This is a left-handed sort of excuse, for persons that have been in a company's employ usually know a good deal of what is going on. The best way to combat these rumours is to issue a report on the properties made by some well-known oil engineer after full personal investigation. This is what we suggested last February.

Lord Cowdray has made further public reference to his oil ventures in Derbyshire and Scotland. With regard to the Hardstoft bore, he said it was as productive as the average American bore, and that the quality of the oil was equal to the best Pennsylvania product. He hoped that by the end of the year the whole of the test wells would be completed. He said, however, that until the law as regards royalties was amended, it was impossible for him to proceed in the matter of production. As usual, the Government stands in the way, and refuses to give any decision as to its policy with regard to royalties.

United States.—The delay in the negotiations for the sale of the mines and smelters of the Arizona Copper Company to American neighbours is causing some anxiety among shareholders, for in the meantime the financial position does not improve owing to the difficulty in disposing of the copper output. The annual report published two or three months ago showed that of the £74,237 profit available for ordinary dividends no less than £64,843 was provided by repayment of excess profits duty. This is an unpleasant factor in the situation. The drop in the demand for copper has certainly had a serious effect on this company.

The McFadden Bill, introduced into Congress with a view to permit gold producers to charge a premium on gold sold for industrial purposes and in the arts, has failed to find support. The American merchants and bankers were against the interference of the Government with the ordinary course of commerce, just as they were in this country. They, of course, know best whether or not it is to their own personal advantage, as against that of the producer, to take this attitude.

The control of the Bully Hill mines, in Shasta County, California, has been acquired by Messrs. Hayden, Stone & Co., and Mr. D. C. Jackling has become managing director of the Shasta Zinc & Copper Co., the corporation formed to operate the property. These mines are noted for the pioneer work in electrolytic production of zinc done there.

Canada.—The mill of the Keeley Silver Mines, Ltd., at South Lorrian, near Cobalt, is approaching completion and should start operations at the end of September. It has a capacity of 80 tons per day. Developments have been good and a substantial reserve of milling ore has been blocked out. In addition a car-load of high-grade ore awaits shipment. On one of the veins at a depth of 300 ft. the milling ore averages from 40 to 90 oz. of silver over a stoping width of 3 ft. It will be remembered that this company was floated recently by the Associated Gold Mines of Western Australia, with financial participation by Hamilton, Ehrlich, & Turk, and the Siberian Proprietary. Dr. J. Mackintosh Bell is the engineer in charge, and the property was examined by Messrs. Edward Hooper and E. T. McCarthy.

Colombia.—The British Platinum & Gold Corporation reports that its first dredge has been launched on the Opogodo property, and that it is expected to commence operations in October. No. 2 dredge is now in course of construction in this country, and plans are being drawn for a third dredge. Mr. D. D. Henderson, of Messrs. Inder, Henderson, & Dixon, is at Opogodo at present.

Spain.—A circular has been issued by the Dome Mining Corporation with regard to an alluvial gold concession on the Orbego river, in the province of Leon, north-west Spain. This circular contains a report made by Mr. A. J. Kelman, manager of the Malayan Tin Dredging company, for Messrs. F. W. & R. Payne. The report deals only with the dredging problem, and the firm was not asked to determine the contents of the ground. Under these circumstances it was hardly fair to Messrs. Payne, Mr. Kelman, and the public to publish the report in the financial press.

The position at Rio Tinto continues bad. It is stated that the directors have sent an ultimatum refusing to consider the workers' demands and threatening to suspend operations indefinitely. The other side of the case is given by a correspondent of *The Times*, who states, on the authority of members of the English staff, that the wages paid to the Spanish workmen are entirely inadequate and are far lower than those now earned by field labourers. The Rio Tinto board is not noted for its love of publicity; will it be moved to reply in detail to the statements made by *The Times* correspondent?

Spitsbergen.—The Northern Exploration Company announces that the issue of 100,000 new shares was a failure, and as an alternative method for raising further funds, £150,000 convertible debentures are now on offer for subscription. It is not likely that these debentures will be taken up.

LATERAL DISTRIBUTION OF METALLIC MINERALS

As illustrated by the Lead, Copper, and Iron Deposits of Cumberland and Lancashire.

By J. D. KENDALL.

THE rocks of the English Lake District, mainly Silurians, are flanked by beds belonging to the Carboniferous, Permian, and Triassic systems, which to a very large extent have a quaquaversal dip, indicating important elevations of the central mass both before and since the Red rocks were laid down. These facts are shown in a general way by Fig. 1.

The lead deposits hitherto worked in the area under consideration, occur, to a very large extent, in either the Skiddaw Slate area—and mostly in a particular part of that area—or in the Yoredales east of the Great Pennine fault. The most important copper deposits have been found chiefly in two widely separated parts of the Borrowdale volcanic rocks, while the principal iron deposits yet found occur in three relatively small areas of the almost continuous belt of Carboniferous beds which everywhere rest upon the upturned edges of the Silurians.

Why is this seemingly erratic distribution in rocks of the same kind and in conditions which do not demonstratively present any special features ? An attempt will be made, in this communication, to answer that important question, as it may lead to many further discoveries of commercial value.

An examination of the Skiddaw Slate area shows that those rocks form a very important anticline, the uncovered axis of which commences about Gillfoot Park, near Egremont, and passes through Dent and Grassmoor to Carrock Fell. Its bearing at the south-west end is about 57° NE-SW. From How Hall to Applethwaite it is about 61° N.E.-S.W., and from there onward it is about 43° N.E.-S.W. That great disturbance seems to attain its maximum uplift in the region of Grassmoor, whence it falls away in both directions until it is hidden at the ends by Carboniferous rocks. The axis of disturbance is shown on Fig. 1 by the line *a*, *b*, the average direction of dip on opposite sides of it being indicated by arrows. Its effect on the Carboniferous Limestone at Gillfoot Park is shown in Fig. 4 of the article on "The Distribution of Ore in Depth," in the May issue of the Magazine. This anticline may have existed in pre-Carboniferous times judging from the manner in which the rocks of Carboniferous age rest on the several members of the Silurian system, but it has had a great upward movement since the Carboniferous rocks were laid down, as shown by Figs. 2 & 3 in "The Distribution of Ore in Depth." In all probability that later uplift amounted to as much as 5,000 ft. in the neighbourhood of Grassmoor. As a consequence thereof, and of the more intense denudation at the higher altitudes, the lower beds of the Skiddaw Slates there, and for some distance on each side, have been brought much nearer to the surface than at the ends of the anticline, toward which the uplift was much less.

The tensile strain put on the rocks by such an upheaval must have been great, and would cause the production of two sets of fractures; one, more or less at right angles to the anticlinal axis, the other, as nearly as could be expected, parallel to it. The latter set would come into existence first, owing to the strain being much greater across than lengthwise of the anticline, the angle of uplift being probably three or four times greater in the former than in the latter direction. As a consequence, the tensile strain in the former direction would be much greater. By what length of time one set of fractures preceded the other would depend upon the rate of elevation.

One of the effects, in the Cleator hematite district, of this disturbance would be the production of the great coal-fault (1, Fig. 1) which is practically parallel to the anticlinal axis. It would also bring into existence the many N.W.-S.E. faults by which the hematite field is intersected. The former may have—the latter certainly have—had one or more differential movements since they were formed, and particularly since the Triassic period. The average bearing of the coal-fault is about 55° N.E.-S.W. That of the Salter and Eskett fault (3, Fig. 1) is about 39° N.W.-S.E., of the Yeathouse fault (2, Fig. 1) about 36° N.W.-S.E., and of Bigrigg fault 30° N.W.-S.E. Many of the others have similar directions. The bearing of the anticlinal axis at its S.W. end being 57° N.E. - S.W., the directions at right angles to that—the direction of the transverse strain—is 33° N.W.-S.E., which is not very different from that of the

FIG. 1.—GEOLOGICAL MAP OF CUMBERLAND AND FURNESS.

A, Carboniferous. B, Upper Silurian. C, Borrowdale Volcanics. D, Skiddaw Slates. E, Eskdale Granite. 1, Coal fault. 2, Yeathouse fault. 3, Salter & Eskett fault. 4, Loweswater lead vein. 5, Yewthwaite lead vein. 6, Brandlehow lead vein. 7, Thornthwaite lead vein. 8, Threlkeld lead vein. 9, Driggeth copper vein. 10, Greenside lead vein. 11, Coniston copper vein. 12, Rotherhope Fell lead vein. 13, Wellgill Cross vein. 14, West Cross Fell vein. 15, Dowgang vein.

N.W.-S.E. faults, along which so many of the hematite deposits occur. Nor is it really different from the direction of the lead-bearing veins.

The bearings of some of the principal lead veins in the Skiddaw Slates are as under:

Vein.	Position on Fig. 1.	Bearing (true) N.W.-S.E.
Loweswater	[illegible]	48°
Yewthwaite	5	28°
Brandlehow	6	35°
Thornthwaite	7	37°
Threlkeld	[illegible]	33°

They are all on the course of the anticlinal disturbance, as well as others of less importance.

A number of copper-bearing veins also occur in the Skiddaw Slates, but only one of them has proved of any commercial value. They are all more or less parallel to the anticlinal axis. Some of these Skiddaw Slate veins carry both lead and copper, like Red Gill vein on the north side of Skiddaw.

In the Borrowdale volcanic rocks (C) there is an important anticline extending from the Eskdale granite area (E), by the Pike of Blisco, to near the upper end of Grasmere Valley (*c*, *d*., Fig. 1). Its average bearing is about 62° N.E.-S.W. On the course of this disturbance there are numerous veins of copper and iron, the former being roughly parallel to the anticlinal axis, the latter mostly at right angles thereto. Both sets of fractures, along which these veins are formed, most probably came into existence during the formation of the anticline; one set—parallel thereto—being due to the tensile strain at right angles to the anticlinal axis, the other resulting from the endwise pull caused by the uplift—which produced the anticline—increasing from the ends toward the centre. The copper veins of Coniston are on the south-eastern flank of this anticline and more or less parallel thereto. The copper veins in the Borrowdale rocks at Driggith and Roughtengill (9) are on the north-west side of the great anticline (*a*, *b*, Fig. 1), extending from Gillfoot Park to the north-east of Carrock Fell, and they are practically parallel to the anticlinal axis.

The Greenside lead vein (10, Fig. 1) is in the Borrowdale rocks, as well as some unimportant lead veins on the east side of Helvellyn and in Grisedale. Both in bearing and country rock they all differ from the lead veins above noticed and most probably had a different origin. The initial fractures, along which the veins occur, seem to have been due to the strain caused by the forcing of the Skiddaw Slates at Ullswater through the overlying Borrowdale rocks, probably not very thick in that neighbourhood.

The relation of the faulting in the Cleator district to the great anticline in the Skiddaw Slates is paralleled by the structural conditions existing in Furness and Millom. The Skiddaw Slates have been pushed through the Borrowdale rocks near High Haume and at Black Comb, and an important anticline—the axis of which is in Furness (*e*, *f*, Fig. 1)—is a result of this upward movement. On the flanks of that anticline some of the most important deposits of hematite hitherto worked in Furness and Millom have been found. A section from Hodbarrow to Lindal Moor, by way of High Haume, is given in Fig. 2. The huge deposit of Park and Ronhead occurs but a little way south of this section and the fine deposit at Askam is close to it on the north side, so that there is on this anticline four of the finest mines in Furness and Millom, besides a large number that are smaller.

Fault 3, in Fig. 2, is the assumed position of an important fault which exists in the Duddon estuary, as shown by the shift of the Coniston and Carboniferous Limestones on opposite sides of that estuary.

There is also a minor anticline (*g*, *h*, Fig. 1), extending from Ireleth to Spark Bridge, which in all probability has been more or less instrumental in producing the numerous faults existing at Lindal Moor, Whitriggs, Cross Gates, etc., along which so much ore has been found. Not one of these faults is shown on the Geological Survey map of the district.

The only other metalliferous district, in the area under consideration, is that of Alston. The lead deposits found there occur in veins in the upper part of the Carboniferous Limestone series—the Yoredales—and mostly in the limestones thereof. The Carboniferous rocks rest on the Skiddaw Slates and other Silurians. The more prolific veins, called "east and west veins," bear about 56° N.E.-S.W., and generally dip north. These are intersected by veins, called "cross veins," bearing about 38° N.W.-S.E. and dipping east in most cases. A third, but much less important set, called "quarter point veins," bear about 78° N.W.-S.E. All these veins are on the flanks of a broad anticline, the axis of which has an average bearing of about 59° N.E.-S.W. (*i*, *j*, Fig. 1), being practically parallel to the east and west veins. Its altitude increases from about Stanhope Common to Knock Fell, where it attains a maximum. The anticline probably came into existence when the Great Pennine fault had one of its differential movements in post-Carboniferous days, by which the Skiddaw Slates were brought to the surface along the foot of Cross Fell escarpment. That fault is about parallel to the "cross veins," the fractures coinciding with which would result from the tensile strain induced by the increasing uplift toward the south-west, just as the "east and west veins" would be preceded by fractures caused by the transverse strain arising from the general elevation of the anticline. As in other similar cases, the "east and west veins" would be formed first.

Within the areas of disturbance coinciding with the several anticlines above described we find all the important deposits of copper, lead, and iron hitherto discovered in the Lake District Silurians and adjacent Carboniferous rocks. The deposits are in every case on the lines of fracture or faulting, the directions of which correspond approximately to those of the anticlinal axes or to the dip of the beds on each side thereof. An exact correspondence could not be expected owing to variations in the physical conditions of the rocks which, in consequence, would offer greater resistance in some places than in others to the fracture-producing strains induced by the several local upheavals.

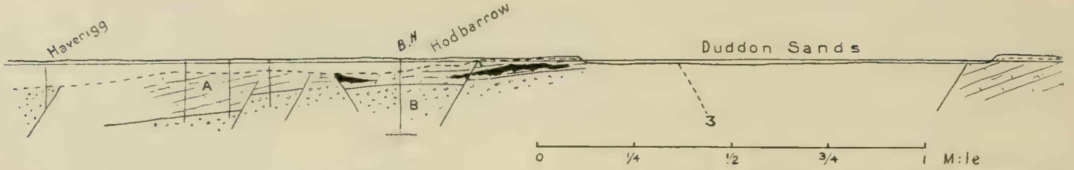


FIG. 2.—SECTION FROM HODBARROW

A, Carboniferous Limestone. B, Basement Conglomerate and Shales. C, Coniston

The breaks would correspond with the lines of least resistance and might, or might not, be exactly at right angles to the lines of breaking strain, as they would have been had the rocks been homogeneous. It is well known that the tensile strength of some rocks is more than four times as great as that of others.

Fractures having been produced in the rocks, differential movements of various amounts would be produced according to the conditions. Underground water would circulate more or less freely in the ground-water zone, along those lines of faulting, and deposits of metallic minerals take place in the manner described in the " Formation of Ore-bodies."*

Perhaps the most suggestive feature of the before-mentioned anticlines, as affecting the Carboniferous rocks that are ore-bearing, is the fact that they are the result of upheavals which have brought the Skiddaw Slates to the surface in the immediate neighbourhood of the ore-bodies. The bearing of this fact on the genesis of the deposits is very important. Moreover, it has a commercial value hitherto unrecognized, as there are other areas in which similar conditions exist that have not been explored for minerals.

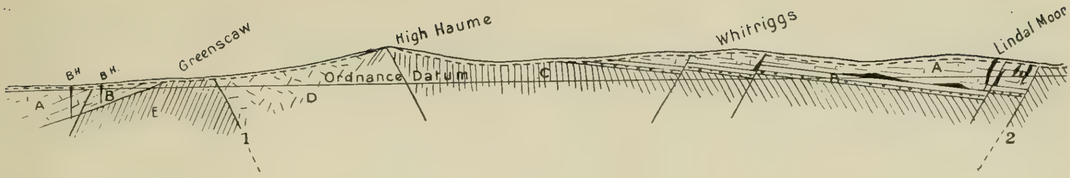
There is a remarkable paucity of metallic mineral deposits in the Upper Silurians, as also in the lower beds of that system outside the areas of the special hypogene activity above described. Nowhere on the long, irregular, but almost continuous belt of rocks belonging to the Carboniferous Limestone series, which surrounds the Silurians, do we find deposits of hematite apart from these disturbed areas. In the Lake District, as already stated, lead occurs most abundantly in the Skiddaw Slates, although it is occasionally found in the overlying volcanic rocks. The more important copper deposits have been found in the Borrowdale rocks, but some small veins, like that at Goldscope, occur in the Skiddaw Slates. All the large known deposits of hematite have been met with in the limestone of the Carboniferous system, but some smaller bodies—as veins—have been worked in the upper beds of the Skiddaw Slates, in the Borrowdale rocks, and in the Eskdale granite. The lead veins of Alston Moor and adjoining districts are chiefly in the limestone beds of the Yoredales, principally in the Great Limestone. The bottom bed of the Yoredales—the Tyne bottom limestone—is over 700 ft. above the base of the Carboniferous rocks.

Why are these lead deposits practically confined to the Yoredales, and do not extend into the Melmerby Scar and other lower limestones? The probable reason is that at the time the ore was deposited the ground-water zone did not extend much below the Tyne bottom limestone on account of the great thickness of the overlying Grits and Coal Measures, since removed by denudation. The aggregate thickness of rocks above the Tyne bottom limestone then was probably not less than 2,500 ft. and of a character that would interfere greatly with underground circulation. The ground-water zone would therefore be comparatively shallow.

This train of thought leads one to ask why, in the Lake District, the lead deposits are found mainly in the Skiddaw Slates, the copper deposits in the Borrowdale rocks, and the iron ores in the limestones of the Carboniferous Limestone series?

As stated in "The Formation of Ore-bodies": " It seems fairly certain that the minerals of the primeval magma would be concentrated, while in a fluid condition, more or less in accordance with the specific gravities of the combined elements; the heavier the mineral the deeper it would sink, other conditions being equal, just as we see in the settlers of a copper smelter the copper-bearing matte sink to the bottom while the lighter silicious slag flows off from the top. The inference is further supported by the fact that the density of the earth, as a whole, is nearly twice that of the average of the minerals accessible from the surface. In the eruptives on and near the earth's surface we find minerals of very different specific gravities in the same rock—for example, quartz and magnetite—but that may be the result of later hypogene action by which minerals from different horizons beneath the surface, that is,

* Trans. Canadian Mining Institute, vol. xxi., 1918.



TO LINDAL MOOR.
Grits and Flags. D, Borrowdale Volcanic Rocks. E, Skiddaw Slate.

of different specific gravities, were brought together. Or, it may be that the relatively small quantity of iron ore found in igneous rocks, generally, became so entangled in the cooling magma that complete concentration and separation into distinct horizons of approximately equal specific gravities could not be effected, just as we find pellets of matte in the slags of copper smelters, even when very large settlers are employed. The minerals forming the major part of what we know as the basic eruptives would, in all probability, form lower zones than the lighter minerals which constitute the bulk of the acid eruptives, but it is easily conceivable how, during subterranean disturbances, they might become more or less mixed. Indeed such a mixture of minerals of different specific gravities may extend downward indefinitely through zones of increasingly heavier materials. The basic eruptives contain more iron than the lighter acid rocks doubtless because the separation would be more difficult in the former case, owing to the higher specific gravity of the associated minerals in the basic magmas as compared with those of the acid magmas.

"The igneous intrusions and extrusions, as well as a large portion of the fault-planes by which rocks are much intersected, extend from unascertained depths below the surface and they both, as well as the ruptured rocks adjoining them, probably formed channels by which the heavier metallic minerals found in ore deposits made their way from the deeper parts of the primeval magma—the barysphere—to the higher levels on which we now find them.

"During the periods of plutonic activity which at no great length of geologic time preceded the birth of ore deposits, the throw of existing faults might be increased, new faults formed, and passes made through the stratified rocks by molten matter forced partly or wholly to the surface. Some or all of such intersections of the strata would form exits for the various metals, or metallic minerals, existing below to the rocks above. Many, if not all, metallic minerals, in all probability, passed up as gases and became dissolved in the water existing in the rocks above. On the depth at which the volcanic action originated would depend the kind of metal that would find its way to the zone of deposition. The metals or metallic minerals having nearly the same specific gravity might in this way be expected to form part of the same deposit, just as we find together chalcopyrite, pyrite, and pyrrhotite.

"Although galena and blende are perhaps invariably associated, they were not formed at the same time. They most probably occurred together in the deep but, belonging to two different chemical groups, they could not be precipitated by the same reagent, unless in a neutral or alkaline solution, although as gases they might rise simultaneously and become dissolved in the same solution.

"The suggestions herein made that vapours of the metallic oxides become dissolved in the acidulated waters permeating the water-bearing zone, afford a reasonable explanation of the fact that deposits do not extend downward to very great depths."

The specific gravity of iron being 7·8, that of copper 8·9, and that of lead 11·25, they might be expected to sink in the barysphere to proportionate depths. But there is a curious fact in connection with zinc and lead (minerals which are perhaps invariably associated in ore-bodies) that would interfere with this. Zinc takes up 1·7% of lead at its melting point (415°C), 5·6% at 650°C, and 25·5% at 900°C. The average specific gravity of a mixture of 25·5% lead and 74·5% zinc is 7·9. Both zinc and lead have such low melting points that it is possible they would be entangled together in the cooling magma, and in that way be prevented from taking up the different positions due to their respective specific gravities, their downward movement being arrested in a plane below that due to zinc, but higher than that of lead, being in fact somewhere about the position of iron, which probably accounts for the association of iron with zinc and lead in such veins as are now being considered.

The above-mentioned facts suggest a reason for lead and zinc occurring chiefly in the positions described. These metals having a low melting point, their gases would not rise very far until they were condensed, and so we find deposits of these metals in the lower beds of the Skiddaw Slate and in the Yoredales separated vertically from Skiddaw Slates by only a few hundred feet of Lower Carboniferous rocks. The gases might in some cases reach the Borrowdale rocks through the medium of favourable faulting—as at Greenside—providing those rocks were not thick. The Skiddaw Slates are estimated to have a thickness of 10,000 to 12,000 ft. and the Borrowdale rocks about the same, so that the gases might have to pass through thousands of feet of rocks, becoming gradually cooler, to reach either the Borrowdale rocks or the Upper Silurians. It must, however, be borne in mind that the ground-water might extend downward several thousand feet, at which depth the temperature might be in those days near boiling point.

The copper and iron gases were probably able to reach higher beds of the volcanic rocks owing to the higher temperature of the melting points of iron and copper as compared with those of lead and zinc.

The limestones containing the hematite deposits of the Cleator district rest on the upper beds of the Skiddaw Slates, and therefore the ground-water in them would not be too high to be reached by the ascending gases. In Furness the Carboniferous rocks rest partly on the Skiddaw Slates and partly on the Upper Silurians. The latter, however, have short connections with the Skiddaw Slates by faulting as shown in Fig. 2; faults 1 and 2 in that section must come together in depth. In other parts of the Carboniferous Limestone area, where those rocks rest on the Upper Silurians, there has not been found a single deposit of any commercial value.

The strata underlying the Carboniferous beds at Hodbarrow have only been proved by boring, but a study of the rocks in the adjacent districts of Kirksanton, Park, and Askam leads to the opinion that they are Skiddaw Slates.

It is assumed by some writers that the hematite deposits were formed by downward filtration from overlying Red rocks. There is not any evidence that such was the case. Where the lead and copper ores came from, these writers do not suggest. There are not any overlying rocks in the vicinity of the veins which can be brought into service in a similar way to the Red rocks, nor any metal-bearing rocks from which the deposits could have been formed by lateral segregation.

The commercial value of the above facts will be evident to explorers whose methods are based on scientific considerations and who have abandoned the happy-go-lucky procedure which still so largely prevails, which puts down a bore in a particular place, or drives a drift in a certain direction for no better reason than that there had not been a bore or a drift there before. The waste of money, in these districts, in unscientific methods of exploration has been enormous.

Now that a Geological Survey Board has been appointed, it is to be hoped that steps will soon be taken to prepare working maps for our three principal hematite-producing districts. That these may be a real help to the mining community it is necessary that the field geologist should have the help of mining engineers familiar with the geology of the districts. The need, and advantage, of such a combination has been admitted for some time in the United States. Mining engineers who take an interest in structural geology must of necessity have much information of value to the miner that a field geologist can never have. This is so well recognized in America that there has come into existence in that country a considerable number of geologists who call themselves "Mining Geologists."

The suggested maps should not be on a less scale than 6 in. to a mile and they should show, *inter alia:*

(1) The outline of every deposit that has been worked, and, in the Cleator district, they should indicate, by figures, the limestones in which the deposits occur or occurred. In Furness they should show which deposits are or were on or near the basement beds, and which are or were in the limestone just under the Yoredales.

(2) Every fault known to exist, their position and depths (O.D.) where proved in the mine, as well as their positions at the surface.

(3) The position of all bores that help to a comprehension of the structure of the ground, indicating by letters and numbers the character and depth of the strata passed through.

(4) Indicate where, vertically and laterally, other deposits are likely to be found.

After these maps have been made—or *pari passu* if possible—attention should be given to other districts on the Carboniferous belt where the conditions suggest exploration, but it should follow the preparation of a geological map made specially to guide the explorer. Similar maps should be made for the more promising ferrous and non-ferrous veins.

ELECTRO-DEPOSITION OF GOLD AND SILVER FROM CYANIDE SOLUTIONS.

A discussion of the late Professor S. B. Christy's work on the electro-precipitation of gold and silver from cyanide solutions.

J. E. CLENNELL, B.Sc., Assoc.Inst.M.M.

(Concluded from July issue, page 27).

The Anode Problem.

The problem of finding a suitable anode, which is the bugbear of all electrolytic work with cyanide solutions, had evidently given much trouble, and is discussed by Christy in some detail (pp. 98-108). The first suggestion is to use a soluble anode, in order to utilize the energy developed by the direct action of the electrolyte on the electrode. The only possible metals are zinc and aluminium. These, being themselves precipitants of gold and silver, are unsuitable unless amalgamated to prevent local action, but in this case the metal becomes extremely brittle and falls to pieces unless the anodes are made very thick, and consequently heavy and expensive.

Insoluble anodes have the disadvantage that they add no energy to the bath, but increase resistance, owing to polarization; but an absolutely insoluble anode, if it could be found, would be the ideal one for continuous use. Platinum would probably answer all requirements, but its cost is, of course, prohibitive. Hard electric-light carbon answers only when the voltage is very low (below 1·48). At higher voltages it is attacked and discolours the solution, though this effect does not apparently interfere with the efficiency of the solution as a solvent for precious metals if the liquid be aerated before use. This form of carbon is said to resist chlorides satisfactorily, but soon succumbs to alkali sulphates. Attempts to increase the durability by boiling in vaseline or paraffin were unsuccessful. Acheson graphite was more resistant, but also failed with solutions containing sulphates. This trouble is said to have caused the abandonment of the Oliver process (amalgamated copper cathodes and Acheson graphite rods as anodes: see p. 11 and p. 99). When the solution contained sulphates these anodes disintegrated into a black mud.

Peroxidized lead anodes gave good results so long as the coating of peroxide was absolutely continuous. The methods of preparation recommended by Christy (quoted from Butters) are: (1) scratching the surface of the lead plates with a stiff brush, then using them as anodes in a 1% permanganate solution for at least 1 hour with a current density of 1 ampere per sq. ft.; or, (2) by making them first cathodes and then anodes in a caustic potash solution containing PbO_2, or in a solution of plumbate of soda. When well prepared, these anodes are said to last for a year, but when any metallic lead is exposed they rapidly disintegrate with formation of a white deposit of hydrate, carbonate, and cyanide of lead. Any bending of the plates causes cracks in the coating of peroxide, and corrosion at once sets in. It is also suggested that under some unknown conditions, the anion ($AuCy_2$ or $AgCy_2$) or its products, may act as a reducer on the PbO_2 and expose metallic lead to the action of the current. A special framework was designed to prevent bending of the metal, which was used in the form of wire. Solid rods of PbO_2 are less suitable, as they are poor conductors.

Unprotected iron anodes are attacked both by chlorides and sulphates, but attempts were made (pp. 103-106) to prepare and use the so-called "passive iron," first suggested as an anode for cyanide solutions by Hittorf in 1900. Christy was unable to find any means of producing these which would give a material capable of resisting a current of 3 or 4 volts in cyanide solution containing chlorides, though he considers that the importance of the subject warrants further research. He states that the most probable cause of passivity is a thin uniform film of magnetic or other oxide of iron, but if the film is too thin it is porous, and if too thick is easily chipped off.

Anodes of magnetite are discussed (pp. 106-108). These may be cut from the native mineral (magnetite or ilmenite), which would be difficult, or formed by agglomerating grains of the mineral with a binder of tar, sugar, or suitable fluxes. This is unsatisfactory, as the binder is attacked. A mass of magnetite grains in a cloth retainer was not sufficiently pervious or conducting. The most hopeful proposal is that of Speckter (U.S. Patent 951,513, August 7, 1909) to use anodes cast in rods, from molten magnetite. Fe_2O_3 is fused, and changes on melting into Fe_3O_4 with some FeO, which must be oxidized by adding a little pulverized Fe_2O_3 to the melt just before pouring. Hollow tubes of Fe_3O_4 are formed, which may be electro-plated in the interior to render them better conductors, or a rod of iron, copper, or nickel may be placed in the interior while the material is still plastic, since magnetite itself is a poor conductor. Such rods were found to be unaffected when used with a 0·2% KCy solution with 1% NaCl or 1% Na_2SO_4 and a current of 4 volts, but the anode was not tested in continuous use for a long time. Christy considers this one of the most promising anodes he has seen, but was informed that the material is not permanent with an alternating current, and was finally abandoned in the Clancy process in favour of Acheson's "extruded graphite" soaked in paraffin.

The Cathode Problem.

The question of a suitable form and material for the cathode is discussed (pp. 108-116). Mercury and copper are condemned as unsuitable except with strong solutions and where regeneration of cyanide and alkali are possible. Aluminium was recommended by S. Cowper-Coles and zinc by Bettel and Andreoli, as giving an adherent deposit capable of being readily stripped, and as being electropositive to gold, thus preventing the re-solution of that metal in case of a stoppage of current. According to Christy, the latter advantage is not obtained, since the gold coating, if continuous, acts as the cathode, and dissolves during a stoppage in spite of the underlying aluminium or zinc. Mercury, if present, has a disastrous effect on the aluminium cathode (as the present writer has also observed) causing it to heat, oxidize, and disintegrate.

Hard carbon and graphite can be used in sheets, both as cathodes and (in the stripping operation, with a low voltage) as anodes, but have the disadvantages of small precipitating surface, brittleness, and high cost. Owing to the friable nature of the material, the sheets must be made $\frac{1}{4}$ to $\frac{3}{8}$ in. thick, whereas with wire cloth, 5 times the precipitating surface may be obtained in the same space.

The possibility of using platinum, sheet iron, or iron-wire cloth is also discussed. The first may be dismissed as altogether impracticable on account of cost. The difficulties due to rusting of iron cloth on exposure have already been noted.

The next suggestion (pp. 113-120) is to use pervious cathodes composed of fragments of coke, hard carbon, or graphite, in boxes having cheese-cloth sides, for which Christy was granted U.S. Patent 756,328, April 5, 1904.

Summary of Process.

To summarize the entire process, the anodes may be of any electro-conducting substance not too much acted on by the solution, such as Fe, Pb, PbO_2, Pt, or (for pressures not exceeding 1·5 volts) dense carbon or graphite in the form of wires, rods, gauze, perforated sheets, or any pervious form. The cathodes may be iron-wire gauze or any pervious conducting substance such as metallic filaments or cloth saturated with precipitated silver, gold, or other metal, as, for example, iron-wire cloth which has previously been used as cathode in a strong solution of Au, Ag, Cu, Pb, or other electronegative metal, using a dense electric current to precipitate the metal in a spongy layer, or granulated metal, pulverized coke, or electrocarbon may be placed in a wooden framework covered with cheese-cloth. In the latter case connection is made by means of an iron wire ending in an amalgamated copper wire. For the clean-up, the primary anodes are replaced by sheets of iron coated with graphite and vaseline, which are used as cathodes, the primary cathodes being so connected as to serve as anodes, thus transferring their deposit to the new cathodes. A rapid circulation of the solution is maintained in both operations, with a velocity of not less than 1 ft. per minute.

Circulation Processes.

On p. 119 it is proposed to use rapid circulation of a large volume of solution through zinc granules, shavings, or dust, the electric energy being supplied without use of any external source by the contact of the electropositive zinc with gold and silver particles deposited in a porous or pervious condition. It is difficult to see how this suggestion differs from ordinary zinc precipitation, except in the repeated and rapid circulation of the solution. Christy claims (p. 120) that by this means practically complete precipitation of 1 oz. of silver is obtained with only 0·57 oz. of zinc, whereas in the ordinary zinc process 5 to 20 oz. would be required. No estimate is made of the power required to circulate repeatedly a large volume of solution through the mass of zinc, and it may be questioned whether the additional outlay for this purpose would not exceed the saving obtained by reduced consumption of zinc.

The same principle of circulation may be used for refining precipitates, thus eliminating the use of acid. A solution of cyanide, nitrate, or sulphate of silver, of cyanide or chloride of gold, or of a soluble salt of copper is circulated through the precipitate until the residual zinc is dissolved. It is obvious that either of these methods must result in a final solution charged with gold or silver, since these metals would redissolve in absence of sufficient zinç, and the precious metals would still have to be recovered in a succeeding operation, with a fresh charge of zinc.

Working Tests on Christy's Process.

On pp. 120-129 an account is given of tests made in 1905 by other investigators at the request of Professor Christy to determine the possibilities of his process under working conditions.

The results obtained by H. W. Hopkins at the Waihi Mine, New Zealand, showed, in the first series, a recovery of 32·3% of the gold and 31·2% of the silver, with a loss of cyanide amounting to 0·004% as the average of 12 tests. In the second series, no gold was precipitated. In the third, a recovery of 61·7% of the gold and 59·3% of the silver was obtained, with no loss of cyanide. These tests were made with flat lead electrodes. The low results are ascribed by Christy to excessive rate of flow, which was 3 to 7 times that suitable for the capacity of the boxes used.

Some reference is made (pp. 122-123) to another series of tests at the Waihi, made with pervious wire-cloth cathodes and perforated sheet-lead anodes, but the details are not given, so that it is impossible to follow intelligently the discussion of results given on p. 123. One remark, however, has an important bearing on the whole subject, namely, that foul mill solutions are harder to treat than clean solutions. Christy states that he has treated many such solutions as well as similar solutions saturated with lime, but most of his experiments recorded in this bulletin were made with pure solutions of $KAgCy_2$ or $KAuCy_2$, and the impression is left that the applicability of the process to working conditions requires further confirmation.

The experiments of A. Scrymgeour, at the Transvaal Gold Mining Estates, Pilgrim's Rest, South Africa, were made with anodes of $\frac{1}{16}$ in. iron plates perforated with $\frac{1}{4}$ in. holes, and cathodes of wire gauze; mesh not stated. A long series of experiments gave an average precipitation of about 25% of the gold with $\frac{1}{2}$ hour's contact, the Siemens-Halske process giving 75% with 4 hours' contact. It was observed that a pure solution of sodium aurocyanide gave 75 to 80% by Christy's process with $\frac{1}{2}$ hour contact; in this case the iron plates were scarcely attacked, whereas with working solutions they became extremely foul with iron and copper cyanides and about 25% of the cyanide was consumed. Christy considers that peroxidized lead anodes should have been used, but as many of the essential working conditions are not recorded it is impossible to explain the poor results. Copper in any case introduces difficulties in the precipitation of gold. Later experiments made with peroxidized lead anodes gave better results, up to 71% recovery, and with pure $NaAuCy_2$, of 95%, with 1 hour's contact. The current density was 0·014 to 0·033 amperes per sq. ft. of cathode surface, which Christy considers insufficient.

The experiments at Roodepoort Central Deep mines, South Africa, were made by Gabriel Andreoli, with perforated sheet-iron anodes and cathodes of mill screening clamped together in sets of 5. The current was 10 to 7 amperes, just sufficient to give an evolution of gas at the electrodes. A total recovery of 91·5% was obtained. This was satisfactory as compared with the Siemens-Halske recovery of 70% at the same plant. Other experiments gave recoveries of 87, 90, 77, and 80%. These tests are of great interest, as they show at least a possibility of the practical application of this process to working solutions, though Andreoli does not confirm Christy's claim of high electric efficiency. It is unfortunate that these tests were vitiated to some extent by the use of old chlorination vats saturated with gold.

Commenting on these results, Christy outlines (pp. 128-129) the conditions required for effective precipitation thus: "The necessity of increasing the flow of solution as the liquid becomes impoverished of its gold and silver content cannot be too positively emphasized. It must be increased till the evolution of gas at the cathodes either ceases or becomes a minimum. . . . The best results are obtained by increasing simultaneously the cathode surface, the current density, and the speed of circulation. The current density should be kept at the highest point that will allow the metal to come down firmly coherent and to increase the circulation so as to reduce gassing at the cathodes to as low a point as is possible with the highest practicable current density. The limit of current density is reached when the metal comes down as a slime, and as it forms is washed off by the solution." He supposes that the experimenters were deterred from using sufficient circulation on account of the large amount of lime in the solutions, which might form deposits on the cathodes, but Christy says that he has treated solutions rich in lime at velocities of several feet per minute through gauze cathodes with no trouble from this source.

Other Electrode Materials.

Reference is made (p. 129) to the Snodgrass apparatus (U.S. Patent 835,329, November 6, 1906), in which the cathode consists of a bottom plate of iron on which rest iron frames faced with wire gauze or wire-cloth coated with plumbago, or plumbago and a lead salt. The anodes are boxes with coarse cloth sides, containing carbon, manganese dioxide, or lead peroxide. The solution flows round, but not through the electrodes, and this is claimed as an advantage. Christy considers that this arrangement would involve large boxes and a difficult and expensive clean-up, but commends the bottom cathode plate as a good feature.

Experiments were made (pp. 130-131) with a product known as "coke whiskers," a peculiarly resistant form of coke which "closely resembles in size, shape, and colour the hair of a negro's head." This material seemed well adapted for electrodes to be used alternately as anodes and cathodes in cyanide solution, but unfortunately a supply on a commercial scale was not procurable.

It was then found (pp. 131-132) that "excelsior fibre," a material extensively used for packing purposes, if burned at an orange heat for an hour after all gas ceased to escape, formed a pervious mass of charcoal of a steel-blue colour, a sufficiently good conductor, and very little acted on when used as an anode in cyanide solution. After all gold and silver have been precipitated, particularly if much KOH is present, there is some action and the charcoal is attacked at a high voltage, giving a colour to the solution, which, however, may be removed by the use of quick-lime. If the solution is thoroughly aerated, its effectiveness as a solvent for gold and silver is not impaired. This material has a smaller area for a given weight than coke whiskers (189 sq. c.m. per gramme as against 300), but nevertheless gave very satisfactory results. It is sufficiently resistant for use as an anode at ordinary voltage without protection.

Compound Pervious Electrodes.

An interesting development of the process resulted from the discovery that a number of pervious electrodes may be interposed between the anode and cathode without the necessity of electrical connections, which latter involve much trouble to establish and maintain (pp. 132-136). These disconnected conductors, which Christy calls "compound pervious electrodes," may be made from sheets of wire cloth or any suitable form of carbon enclosed in a container through which the solution can penetrate freely. The side nearest the anode becomes positively charged and that nearest the cathode negatively charged, while between the two is a neutral zone in which no action due to the current takes place. Precipitation occurs to a depth of $\frac{1}{8}$ to $\frac{1}{2}$ in., depending on the compactness of the conducting material. When one of these compound electrodes becomes sufficiently charged with precipitate, it may readily be removed and replaced by a fresh one without interfering with the electrical connections in the least. This obviously simplifies the clean-up. Only the initial and final electrodes in the box require to be connected with the source of current. As many as 39 compound pervious electrodes may be interposed. A patent for this arrangement was obtained by Christy, March 31, 1908 (U.S. Patent 883,170).

Details of Experimental Plant.

Pp. 137-144 are devoted to a description of an experimental plant for testing the capabilities of the process, and figures are given showing several possible arrangements of the deposition boxes, a working model of the process, arrangement of lamps for resistance, and a pervious charcoal cathode coated with a deposit of silver.

The dimensions of the electrode frames used by Christy may be of interest. Each box is $4\frac{1}{2}$ in. wide by $5\frac{1}{4}$ in. high, with inside dimensions $3\frac{13}{16}$ by $4\frac{5}{16}$ in. The box is $\frac{1}{2}$ in. deep, so that the inner cross section is 16 sq. in. Christy recommends for future use an inner cross section of 4 by 4 in., or $\frac{1}{9}$ sq. ft. or 1 sq. decimetre.

Cheese-cloth is stretched over the inside and lapped over the outside, and fastened to the frame by a coat of "P and B paint." Such a box holds 8 to 10 grm. of excelsior charcoal in a space of 10 by 10 by 2·5 cm. For compound pervious electrodes of this size at least 10 grm. of charcoal should be packed into each box. The boxes are spaced $\frac{1}{4}$ in. apart. The initial and final electrodes are provided with a rod of Acheson graphite, for electrical connections. Two boxes, with 14 compound electrodes, having 28 current gaps, require a voltage of 110. A small centrifugal pump is required for circulating the solution at 2 to 5 litres per minute. If the interstitial space is about $2\frac{1}{2}$ litres, the rate of flow will be 1 to 2 ft. per minute.

Some of the difficulties encountered and remedies proposed are noted on p. 139. The detrimental effect of sulphates in solution on iron anodes has already been noted. When these salts are present, Christy prefers to use anodes of lead wire about $\frac{1}{8}$ in. diameter, coated with PbO_2 and fitted in a wooden frame coated with "P and B paint." Rich solutions sometimes deposit silver so rapidly as to clog the filter cloth, necessitating frequent removal. With solutions which are foul with lime and ferrocyanide there is often considerable resistance to circulation. The remedies are, to reduce the speed of flow or increase the grade of the box. Toward the end of the operation, when the charcoal becomes choked with hydrogen bubbles, the grade of the box must be increased, or the solution may overflow. The grade recommended for rich solutions is 1 to $1\frac{1}{2}$ in. per foot.

In using compound pervious electrodes, some care is necessary in packing the charcoal, to avoid the presence of passages for the electric current through the solution and not through the charcoal. There should be a uniform fall of voltage throughout the box, and it is preferable to make the first anode a graphite comb, or a frame of peroxidized lead wires, as these give a more uniform distribution of current than the excelsior charcoal anodes. The end cathode usually becomes more rapidly coated than the others, and requires more frequent renewal. For compound pervious electrodes, about 5 lb. of charcoal is used per cu. ft. of cathode space, and for simple electrodes about $2\frac{1}{2}$ to 3 lb.

Best Conditions of Precipitation.

The remainder of the report (pp. 144-162) is devoted to details of tests to determine the best conditions of precipitation. The small-scale tests were made with 20 litres of solution, but before attempting to apply the process on a large scale it is recommended that charges of 500 litres should be treated.

The presence of silver may be detected without assaying, by mixing 1 cc. of the solution with dilute H_2SO_4, which gives a white turbidity. This would not answer with plant solutions containing copper, zinc, and other metals which also yield white precipitates with dilute H_2SO_4 in cyanide solution. With uniform voltage, the rate of silver precipitation is denoted by the fall in amperage, and in recording tests it is desirable to represent this graphically by plotting curves. The most economical point at which to stop precipitation is when the cyanide content ceases to increase and begins to decrease.

The method of evaporation on lead foil is recommended for solution assays. The zinc-lead acetate-HCl method is also used (with the addition, in the case of low-grade gold solutions, of a small quantity of $AgNO_3$, as a collector to prevent loss of gold in cupellation). This method is ascribed to F. J. Buel. As it has long been in use under various forms, and has been credited to different investigators, it would be interesting to ascertain who was the real originator of it.

The necessity for reliable ammeters and voltmeters, and of recording their readings is emphasized (p. 146), and there is also a plea (p. 147) for the use of the metric system. In experimental work of this kind it is an obvious advantage to use a uniform system of measurement, and one having commensurable units.

Experiment showed that ordinary charcoal could not be substituted for excelsior charcoal (pp. 147-148), as it is practically a non-conductor. A small precipitation of silver, about 1% of its own weight, takes place on excelsior charcoal without the electric current.

In absence of protective alkali a slight loss of cyanide occurred in circulating the solutions for 8 hours with a centrifugal pump, the strength of solution falling from 0·1 to 0·093% KCy. This is ascribed to CO_2 in the air.

The following data obtained in the final tests recorded in the report may be noted: An experiment conducted with four simple pervious electrodes of excelsior charcoal gave, with a pure $KAgCy_2$ solution, a precipitation of 92·24% of the silver in 4 hours and practically complete precipitation in 7 hours, but it was shown that the treatment was uneconomical after the 4th hour. The KCy, after 4 hours, had increased from 0·099 to 0·188%, but beyond that point diminished to 0·154% at the end of 7 hours. Twenty litres of solution were circulated about once per hour, this amount being six times the capacity of the box.

A gold cyanide solution containing originally \$5·85 gold per ton showed complete precipitation in 4 hours, with similar treatment. There was no regeneration of cyanide, but on the contrary a diminution from 0·097 to 0·0675 per cent.

A similar experiment in which five compound pervious electrodes 1 in. thick and one simple cathode were used gave a precipitation in 3 hours of 98% of the silver and 99% of the gold. The space between electrodes was $\frac{1}{2}$ in., giving 6 current gaps of $3\frac{1}{2}$ volts, or a total of 21 volts. Experiment showed that a current-gap of $\frac{1}{4}$ in. was preferable to one of $\frac{1}{2}$ in.

In another experiment, on a mixture of KCy, KOH, and $KAgCy_2$, the free KCy rose from 0·0985 to 0·183% in 4 hours, when more $KAgCy_2$ was added. The final free KCy strength after 8 hours was 0·236%. In the first stage, there was a precipitation of 98·69% of the silver, in the second, of 99·7 per cent.

Precipitation of Solutions containing Lime.

Nearly all these tests were made with pure solutions, and it is to be regretted that more work was not done with liquors comparable to those which would necessarily occur in practice. The tests on the effect of lime (pp. 154-157) are of special interest, as they indicate the influence of one at least of the inevitable impurities. Compound pervious electrodes were used, and one simple Acheson graphite comb anode. There were 11 cells each ½ in. thick with eleven ¼ in. gaps, or a total of 38½ volts; 20 litres of solution were circulated for 8 hours; this solution contained 20 gm. KCy, 10·2 gm. CaO, and 24·43 gm. silver as $KAgCy_2$. With a rate of flow of 144 tons per 24 hours in a 1-ton box, the precipitation of silver was 93·5% in 1 hour; when the rate of flow was diminished to 72 tons per 24 hours, the precipitation of silver was 99·5%. Cyanide of calcium was formed at the expense of free CaO, indicated by a rise in cyanide content accompanied by a fall in protective alkali. These effects ceased after the precipitation of silver, and the cyanide strength then began to fall.

There seems to be some advantage as regards gold precipitation in giving the cathodes a preliminary coating of silver (see p. 158). All the tests showed that it was economical to stop the precipitation before it was actually carried to completion, as toward the finish the rate of deposition greatly diminishes and the current is harmfully consumed in decomposing cyanide. Christy, therefore, proposed to use the solution again for ore-extraction after the gold content has been reduced by 90%. This, in the case cited, where a solution of 1¼ oz. gold per ton was used at the start, would give a "barren" leaching solution of 0·125 oz. per ton, which would hardly be considered satisfactory in ordinary practice. It would probably pay better to aim at more complete precipitation, even at the expense of cyanide.

Conclusion.

To sum up the impression produced by a careful study of this bulletin, it may be said that the process is of great interest from a scientific point of view, and perhaps contains possibilities which might be developed into a system of practical value. The advantage of the method over the modern perfected methods of zinc precipitation, however, is not clearly demonstrated. The only point of superiority actually pointed out is the regeneration of cyanide due to electrolysis of the double silver and gold cyanides. That in most cases the saving from this source would be small may be inferred from figures in a paper by H. A. White, recently published by the Chemical, Metallurgical, & Mining Society of South Africa (reproduced in the Magazine for May), in which the causes of zinc consumption are investigated. Only 1·2% of this consumption is due to precipitation of gold and silver, and as the solutions to be precipitated on the Rand carry only about 0·1 oz. gold per ton, the KCy saved by substituting electric for zinc precipitation would amount to not more than 0·05 oz. per ton of solution (see p. 75). The main causes of cyanide consumption are the reactions on base metals and acid salts in the ore, and it is by no means evident that these would be materially reduced by any known system of electric precipitation (see pp. 75-76). When we consider the additional cost of installation, the greater labour involved in working a more complex system, the greater amount of skill and supervision required, and added costs for power in the electric process, it requires some unquestionable advantage to warrant the replacement of existing methods.

Thermostatic Metal. — The British Thomson-Houston Company is now putting on the market a "thermostatic metal," which is made by the American General Electric Company. This metal is a duplex strip, formed of two metal strips having widely different coefficients of expansion, welded together along their entire length. When the strip is subjected to change of temperature, one half will expand or contract more quickly than the other, causing the strip to bend. It is supplied in various thicknesses from 0·015 to 0·25 in. in section. Thermostatic metal is far more sensitive to heat than the ordinary thermometer or any previous form of thermostat. A single degree of temperature change will affect its curvature to a measurable extent. When it bends it exerts a considerable force, which can be used for the operation of levers, and the opening and closing of valves, etc. It will provide the necessary compensation for any apparatus which it is desired to make independent of temperature variations.

THE NICKEL-COPPER MINES OF SUDBURY.

By DR. J. MACKINTOSH BELL.

We reproduce herewith a lecture delivered at Harvard University, describing the Nickel-Copper Mines of Sudbury, Ontario.

INTRODUCTION.—The Sudbury nickel-copper area not only supplies by far the greatest portion of the world's nickel requirements, but, in addition, it adds considerably to the copper output, besides supplying appreciable amounts of such rare elements as platinum and palladium. Like other great mineral districts in Northern Ontario it owes its discovery to railway construction through what was formerly regarded as a wilderness fit only for the lumberman and the trapper. The first discovery was made in 1884 in a cutting on the main line of the Canadian Pacific Railway. This later became the Murray mine. Soon afterward the famous Copper Cliff mine was opened, at first for copper and later for nickel. Within four years of the first discovery most of the important deposits had been found, though even within the last few years a large and important deposit was discovered in a hitherto unproductive section of the camp—on the Falconbridge property—as the result of a campaign of scientific exploration by the E. J. Longyear Company, of Minneapolis.

TOPOGRAPHY.—The Sudbury nickel-copper field covers an elliptical area of 40 miles by 16 miles. The inner part of the ellipse consists of a basin of the latest Pre-Cambrian sediments, overlain by glacial beds. This basin is surrounded by somewhat rugged hills, which have a maximum local relief of 500 ft., and which merge outward into the topography characteristic of the Pre-Cambrian highlands of Canada, rocky hills, ridges, and sand plains diversified by rapid streams and numerous lakes. The flat or gently-inclined surface of the basin through which the streams meander quietly is now occupied by a progressive agricultural community, largely made up of miners who have retired to the land.

Sudbury, the principal town of the locality, lies to the south of the basin. Its well-built streets, its numerous fine public buildings, and its excellent public conveniences testify to the great faith in the future of the local mining industry. The town has a population of about 8,000, and is well supplied with transportation facilities by the Canadian Pacific Railway and its branches, and by the Canadian National Railways.

GEOLOGY.—The generally accepted classification of the rocks of the district is as follows :

POST KEWEENAWAN ?	Dykes of diabase and granite.
KEWEENAWAN ?	Nickel-bearing eruptive sheet.
HURONIAN. *Upper.*	(*a*). Chelmsford sandstone.
	(*b*). Onwatin slate.
	(*c*). Onaping tuff.
	(*d*). Trout Lake conglomerate.
Lower.	Ramsay Lake conglomerate.
LAURENTIAN.	Granite and gneiss.
SUDBURY SERIES.	(*a*). Greywacke, slate.
	(*b*). Quartzite, schist, and fine-grained gneiss.
KEEWATIN.	Iron formation, greenstones, and green schist.
GRENVILLE SERIES.	Crystalline limestone and quartzite.

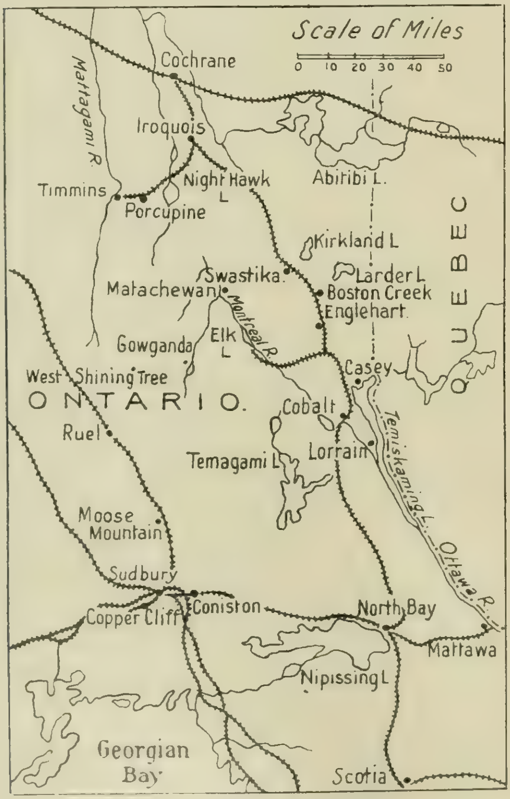
Apart from the above sequence there are a variety of eruptive rocks—gabbro, norite, and greenstone—to which no definite position can be assigned. They are, at any rate, thought to be older than the nickel-bearing eruptive, but younger than the Sudbury series.

It does not come within the scope of this paper to describe the geology in detail. It has already received ample attention from numerous writers, chief among whom were Barlow and Coleman. Suffice it to say that all Pre-Keweenawan rocks are highly metamorphosed, and even the Keweenawan considerably so in certain localities.

From an economic standpoint interest centres in the Keweenawan nickel-bearing eruptive with which the nickel-copper deposits are invariably associated. This eruptive is intruded between the Lower Huronian and earlier rocks on the one side and the Upper Huronian on the other, in the form of an immense laccolithic sheet with a thickness varying from half-a-mile to two miles, and averaging a mile and a quarter, and with an almost constant dip inward toward the interior of the basin. The synclinal character of the sedimentary rocks within the latter and of the laccolith itself is due to their subsidence, following the collapse of the rocks beneath the laccolith after its intrusion.

Judging by the occurrence of isolated outliers of rocks similar to those of the laccolith, it is presumed that it was formerly much more extensive than at present and that large quantities of it, as well as the associated rocks, have been removed by the long-continued erosion the region has undergone. Apophyses from the laccolith extend outward in a few places from the rim.

Petrologically considered the eruptive shows a gradual gradation from norite on the outer to micropegmatite on the upper side. Toward the bottom the norite contains in places blebs of pyrrhotite and chalcopyrite which pass



PART OF NORTHERN ONTARIO.

(generally where there is a depression in the underlying floor) without any apparent break into ore-bodies sometimes of very great proportions.

The fresh norite consists mainly of hypersthene, augite, plagioclase, biotite, and quartz. In many places the rocks have undergone alteration resulting in the change of the pyroxenes to hornblende, uralite, chlorite, and serpentine. The norite containing blebs of ore is ordinarily called "spotted" norite. Schistosity is locally developed within the norite.

NATURE OF THE DEPOSITS.—The ore deposits are divided into two more or less definite types: marginal deposits and offset deposits.

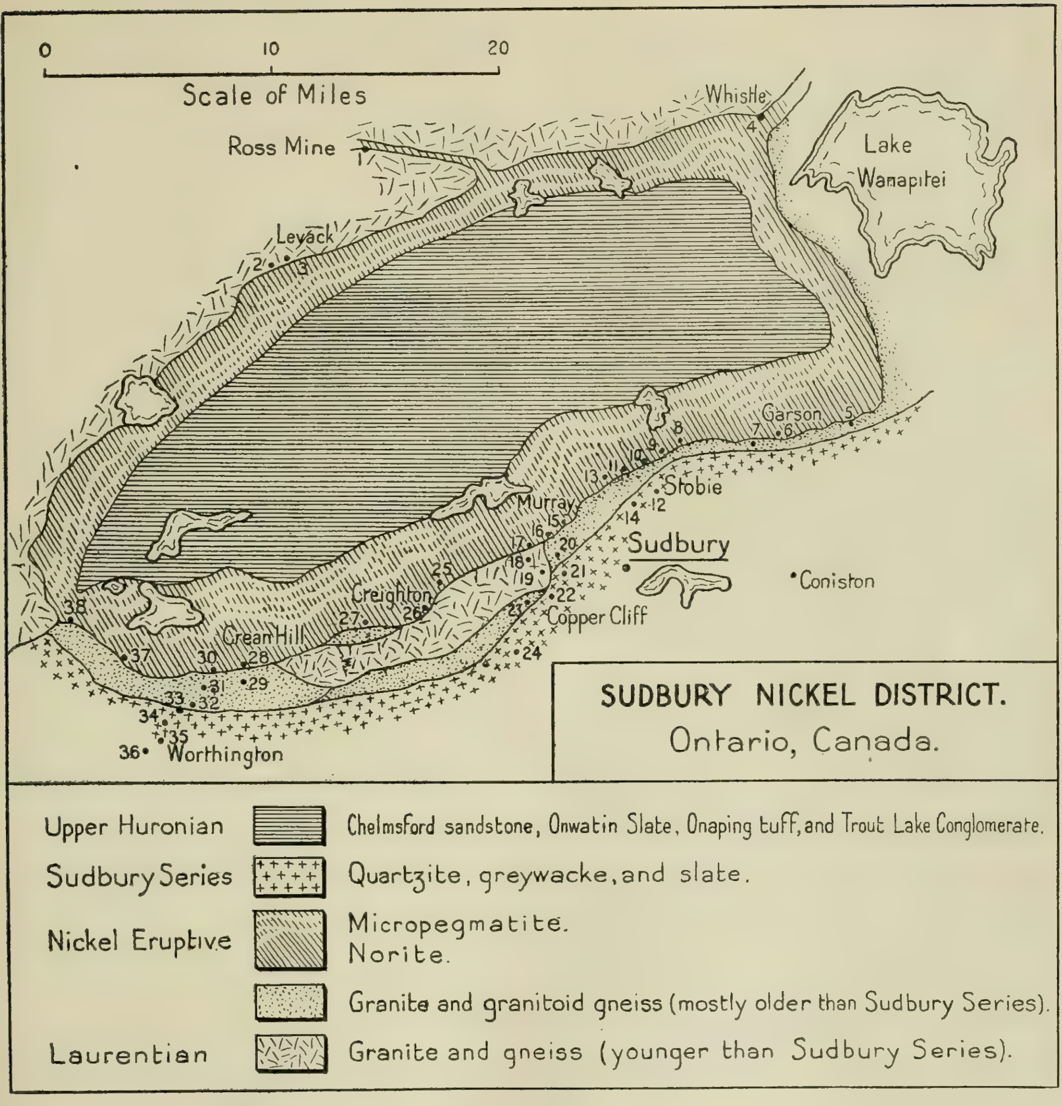
Marginal deposits, as their name implies, occur at the margin of the laccolith and the underlying rocks which may belong to the Sudbury series, to the Laurentian granites and gneisses, or to other rocks. Ordinarily they are found where the laccolith is relatively thick and where it forms an embayment into the underlying rocks, a trough therein dipping beneath the laccolith. One of the best examples of this type is the Creighton, probably the richest ore-body of the district.

Offset deposits occur at points where channels lead out from the embayments and carry ore associated with norite to various distances from the margin of the laccolith, in places three or four miles. The Copper Cliff deposit and many others which will be mentioned later are of this type. It is thought possible that the offset deposits represent former deep-seated zones of weakness which correspond with faults in the overlying Upper Huronians.

The sulphide minerals consist in the order of their abundance of pyrrhotite ($Fe_{11}S_{12}$), pentlandite ($FeNiS_2$), and chalcopyrite ($CuFeS_2$). Pyrite is rarely found. The sulphide minerals contain appreciable quantities of gold, silver, palladium, and platinum. Apparently these are associated more particularly with chalcopyrite than with pyrrhotite. The platinum is thought to occur in the form of sperrylite; no palladium or silver minerals have been identified. The association between pentlandite and pyrrhotite is intimate. Chalcopyrite occurs generally in distinct crystalline areas.

While the ore-bodies are invariably directly connected with the norite, the country rock may be norite or any other of the rocks underlying, and any of the component minerals of the latter may consequently form part of the gangue which at times shows free quartz. Calcite is exceedingly rare. The original silicates are altered to tremolite, chlorite, &c.

A large proportion of the material of the ore deposits consists of country rock, but there is every gradation from the generally sparsely impregnated hanging or foot-wall material—spotted ore—to practically massive sulphide. Apparently, chalcopyrite is as abundant in the rocky ore as in the richer varieties, but pentlandite increases as the amount of rock decreases and seems to have a constant ratio to the amount of pyrrhotite present.



MINES TO WHICH REFERENCE IS MADE IN THE ABOVE MAP.

1 Ross
2 Strathcona
3 Big Levack
4 Whistle
5 Falconbridge
6 Garson
7 Kirkwood
8 Sheppard
9 Blezard
10 Mt. Nickel
11 Little Stobie
12 Stobie
13 Cameron
14 No. 3
15 Murray
16 Elsie
17 Violet
18 No. 6
19 No. 5
20 No. 4
21 No. 2
22 Copper Cliff
23 No. 1
24 Evans
25 North Star
26 Creighton
27 Gertrude
28 Crean Hill
29 Vermillion
30 Victoria
31 McIntyre
32 Gersdorffite
33 Robinson
34 Howland
35 Worthington
36 Totten
37 Chicago
38 Sultana

The average grade of the ore is about 5% in combined nickel and copper, but in certain deposits was considerably higher. Where copper is more abundant nickel is less so, and vice versa.

A detailed microscopical study of the ores was made by Tolman and Rogers,* who give the age succession of the minerals of the deposits as follows:

(1). Silicates (original).
(2). Magmatic alteration of pyroxene to hornblende.
(3). Magnetite.
(4). Pyrrhotite.
(5). Pentlandite.
(6). Chalcopyrite.
(7). Hydrothermal alteration of silicates to tremolite, chlorite, &c.

According to this succession the ore minerals are later than the magmatic ferromagnesian silicates, but earlier than any minerals resulting from hydrothermal activity.

While the deposits are found at numerous places around the edge of the sill there are many parts of the margin which have not been proved productive, especially where the sill is narrow and assumes the form of a re-entrant rather than an embayment.

The deposits exhibit the usual irregularity in dimensions of other sulphide bodies similarly formed. They commonly have great longitudinal extension as compared with the lateral dimension. Some of the mines have been worked to 3,000 ft. on the dip, and certain ore-bodies are believed to extend much deeper. Some of the deposits are columnar in shape, with the longitudinal dimension but little greater than the lateral, and with remarkable continuation downward. The No. 2 mine at Copper Cliff comes under this category. Two deposits with small surface dimensions at Victoria mine have been traced downward for 1,600 ft.

The Frood-Stobie is much the largest ore deposit known in the district. It strikes north-east and south-west in a narrow gossan-covered ridge, with one or two slight interruptions, for nearly two miles. It is of the offset type, and in its course touches several different rocks, including norite, but at no place approaches nearer than $\frac{3}{4}$ mile to the edge of the laccolith proper. Diamond-drill records prove that the deposit dips at first at an angle of 60° to 70° towards the latter and then flattens somewhat, suggesting, as Coleman indicates, an underground connection with the parent sheet. The Frood-Stobie deposit has been proved to contain upwards of 35,000,000 tons of ore.

The Murray ore-body, which is a marginal deposit and continuous with the Elsie, shows a gossanous outcrop about a mile in length. It averages 70 ft. in width and has been traced down the dip, which is usually at about 36°, below the norite for 3,600 ft. It contains more than 16,000,000 tons of ore.

The ore-body recently discovered by the E. J. Longyear Co. in the western part of the township of Falconbridge has a length of 7,500 ft.

The Frood-Stobie, Murray, and Falconbridge represent some of the largest ore-bodies, but there are many others of every size, some of which have scarcely yet been developed at all or have produced anything from 100,000 to 200,000 tons of ore.

About 1,500,000 tons of ore are now being annually raised at Sudbury. At this rate of output there is probably at least 50 years' ore in sight, with large sections of undeveloped ground which may be expected to greatly increase this large reserve.

GENESIS OF THE ORE-BODIES.—The genesis of the Sudbury ores has been the subject of great discussion by many leading geologists and mining men, and unanimity of opinion as to their origin has not yet been reached.

The conflicting theories are all based upon certain facts as opposed to inferences, which have been well summarized by Roberts and Longyear in their able paper on the genesis of the Sudbury ores.*

The facts as given by the authors are as follows:

(1). The ore occurs at or near the margin of the main norite mass. Even where the ore occurs in offset deposits, that is, not adjoining the sill, norite is invariably associated with it or in close proximity.
(2). The ore minerals are later than the rock-forming minerals.
(3). The ores penetrate and replace the foot-wall rocks to some extent.
(4). The rock associated with the ore appears to be more or less brecciated.
(5). The walls of the commercial ore-body are usually sharply defined mineralogically.
(6). The norite wall (hanging) is always spotted with sulphides; the foot-wall is in places spotted, elsewhere barren.
(7). The mineralogical content of the deposits is remarkably uniform with a fairly constant ratio between the amount of pentlandite and pyrrhotite, although with a slightly more variable quantity of chalcopyrite.

* C. F. Tolman, Jr., and A. F. Rogers, "A Study of the Magmatic Sulphide Ores." Leland Stanford Jr. University publications. University series 1916.

*"Genesis of the Sudbury Nickel-Copper Ores as Indicated by Recent Exploration." By Hugh M. Roberts and Robert Davis Longyear. Transactions of the Canadian Mining Institute, vol. xxi.

(8). The usual minerals accompanying typical hydrothermal deposits are scarce or lacking, and in many places the norite associated with the ore is unaltered.

(9). The norite laccolith has been differentiated into an upper stratum of acid material and a lower stratum of basic material. Within the basic material are minor amounts of acid rocks.

A number of hypotheses as to the origin of the ore-bodies has been developed upon the basis of these facts, the most important of which may be summarized. Barlow,* who wrote one of the earliest memoirs on the district, considered that the ores were formed by a process of magmatic separation on the cool edge of the norite and that they were crystallized prior to the other minerals therein. Coleman[1] believes that the ores were precipitated by gravity, not as crystals but in the form of a melt. Howe[2] and Bateman[3] are of the opinion that the ores were deposited from an intrusion of molten sulphides which was distinct from the norite magma and took place in a deep-seated reservoir.

A number of geologists, including Dickson and Knight,[4] considered that the ores were not separated directly from the norite magma and have no immediate connection therewith. They believe they were introduced by hydrothermal solutions ramifying along the contact of the laccolith with the underlying rocks subsequent to the solidification of the norite. The ultimate source of the metals in the solutions may have been the same subterranean reservoir as supplied the norite.

Tolman and Rogers believe that the sulphides were extracted from the norite during its process of crystallization by the mineralizers present and were deposited as the final stage of the consolidation of the magma.

Roberts and Longyear hold that while the norite was consolidating, the sulphides were segregated in solution and made their way, under the influence of complex chemical and physical forces, to the base of the norite where they were precipitated. With this view, they point out, it is merely a matter of emphasis as to whether the ores are considered to be of magmatic or hydrothermal origin, though the dominant factor controlling the deposition is magmatic segregation in situ.

Briefly considered, I believe the origin of the Sudbury ore to have been as follows: The sulphides were originally separated in the unconsolidated magma by gravitational segregation towards the bottom of the laccolith. The non-sulphide minerals of the magma were the first to crystallize. The sulphides, owing to the presence of mineralizers, remained longer in solution, probably for relatively a considerable period, and were later precipitated in the more or less open or easily permeable locations provided by the contact between the laccolith and the underlying rocks or zones of weakness in the latter into which the magma had penetrated. That solution was active is evidenced by the impregnations in places of the wall-rock antedating the norite and by the presence of quartz and carbonates in certain deposits, as at the Crean Hill mine, where water was evidently conspicuous. On the other hand, the invariable connection of the ores with the norite seems to preclude the possibility of their being deposited by hydrothermal solutions subsequent to the solidification of the norite. The small amount of norite connected with the offset deposits probably had an upward connection with extensive portions of the laccolith which have long since been removed by erosion.

The able papers by Mr. W. H. Goodchild, in THE MINING MAGAZINE during 1918, on the Evolution of Ore Deposits from Igneous Magmas, throw much light on the processes which were probably at work during the formation of the Sudbury ores.

COMPANIES AND PROPERTIES.—There are three important mining companies at present operating in the Sudbury district. These are the International Nickel Corporation of Canada, the Mond Nickel Company, and the British America Nickel Corporation.

The International Nickel Company began operations in 1886 and has worked continuously since. It is now much the most important nickel producer in the world. Its mines include the Copper Cliff, the No. 2, the Creighton, Crean Hill, and Frood. The first two mentioned, which were very rich deposits, are not now being worked. The Frood, with the Frood Extension (belonging to the Mond Nickel Company) are on the Frood-Stobie deposit already described.

The Creighton has so far been the most productive mine in the district. It is regarded as a typical marginal deposit, the geological location being structurally ideal for the location of

*A. E. Barlow, "Report on the Origin, Geological Relations and Composition of the Nickel-Copper Deposits of the Sudbury Mining District, Ontario." Canadian Geological Survey Bulletin 96 (1907).

[1] A. P. Coleman, "The Nickel Industry with special reference to the Sudbury Region." Canadian Dept. of Mines.

[2] E. Howe, "Petrological Notes on the Sudbury Nickel Deposits." *Economic Geology*, 1914, No. 9.

[3] Bateman, A. M., "Magmatic Ore Deposits." Sudbury, Ont. *Economic Geology*, 1917, No. 12.

[4] C. W. Knight, "Origin of the Sudbury Nickel-Copper Deposits." *Engineering and Mining Journal*, May 6, 1916.

C. W. Dickson, "The Ore Deposits of Sudbury, Ontario." Trans. A.I.M.E., 1904.

a large ore-body. It was opened in 1901, and has so far given more than all the other mines of the locality combined. It has, in fact, been practically the dominant factor in the world's nickel production. Its ore is richer than that of any other deposit at Sudbury, excluding Copper Cliff. The better grade ore of the mine contained about 2% of copper to 5% of nickel.

The ore of the Crean Hill deposit, which is partly marginal and partly offset in nature, approximately reverses the proportions of nickel and copper in the Creighton ores. The mine was for a long time the most important producer of copper in the province of Ontario. It is not now working.

During 1917, the ore production of the International Nickel Company, distributed by mines, was as follows:

	Tons.
Creighton Mine ...	1,003,814
Crean Hill Mine ...	113,908
No. 2 Mine ...	1,907
Total ...	1,119,629

The Mond Nickel Company began work in 1899 at Victoria mines, about 22 miles west of the town of Sudbury, and has since become an important producer. The company owns the Garson, from which most of its ore has been obtained, the Worthington, Levack, and Frood Extension. The ore production of the various working mines of the company in 1917 was as follows:

	Tons.
Garson Mine	116,968
Victoria No. 1 Mine ...	45,972
Worthington Mine ...	75,012
Levack Mine	88,587
Bruce Mine	34,796
Total	361,335

The British America Nickel Corporation, which was formed in 1913, took over the properties of the Canadian Nickel Corporation. Among its many large and important holdings are the Murray, already mentioned, the Whistle, Gertrude, and Elsie. The only one of these mines at present working is the Murray, which is being actively developed on an extensive scale.

OUTPUT. — The table shows the amount of ore raised, the amount of ore smelted, and the quantity of nickel and copper produced, from the beginning to the end of 1918.

In addition to nickel and copper, the ore contains palladium and platinum, and a very little cobalt, but exact figures as to the amount of each of these elements which the field has produced are difficult to obtain. The cobalt production is, relatively speaking, quite unimportant.

NICKEL-COPPER PRODUCTION OF THE SUDBURY MINES.

Year	Ore Smelted Tons	Nickel Produced Tons	Copper Tons
1890	59,329		
1891	71,480		
1892	61,924	2,082	1,936
1893	63,944	1,653	1,431
1894	87,916	2,570½	2,748
1895	86,546	2,315¾	2,365½
1896	73,505	1,948½	1,868
1897	96.094	1,999	2,750
1898	121,924	2 783¾	4,186¾
1899	171,230	2,872	2,834
1900	211,960	3,540	3,364
1901	270,380	4,441	4,197
1902	233,388	5,945	4,066
1903	220,937	6,998	4,005
1904	102,844	4,729	2,042
1905	257,745	9,503	4,525
1906	340,059	10,776	5,260
1907	359,076	10,602	7,003
1908	360,180	9,563	7,501
1909	462,336	13,141	7,873
1910	628,947	18,636	9,630
1911	610,788	17,049	8,966
1912	725,065	22,421	11,116
1913	823,403	24,838	12,938
1914	947,053	22,759	14,448
1915	1,272,283	34,039	19,608
1916	1,546,215	41,299	22,430
1917	1,453,661	41,887	21,197
1918	1,559,892	45,886	23,557
Totals	13,280,104	366,276½	213,845¼

METHODS OF MINING.—In the Sudbury district every stage of mining activity is visible, from a test pit or trench sunk on a gossanous outcrop to the completely developed and well-organized mine, raising over 5,000 tons of ore daily. While there are dozens of properties scattered around the edge of the laccolith, which may be considered beyond the prospect stage, not more than twenty-five have actually produced ore on a commercial scale, while those which have supplied more than 100,000 tons of ore do not number more than 12 or 13.

The methods of mining vary considerably in the several mines. Ordinarily, development commenced with open-cuts which in some of the larger mines, such as the Creighton, extended to a depth of 200 ft. The underground methods pursued below the open-cuts show variation from mine to mine. The system followed is, however, commonly an adaptation of the pillar-and-stall plan, the pillars not necessarily being at regular intervals, but corresponding to the poorer portions of the ore-bodies. If the ore-body being mined is more or less uniform and contains inconsiderable areas of waste rock, the pillars in ore are removed before any particular level is abandoned.

In the Crean Hill mine, where there were in the nickel-bearing portion of the deposit appreciable amounts of waste rock, the ground was blocked out by exploratory drifts carried to the confines of the mineralized section. Wherever enrichments occurred the drifts were widened, raised to a height of about 16 ft., and then continued as breast stopes. As development continued upward the pillars of rock unfit to be mined were reinforced by walls of waste culled below ground and further supported by similar material returned from the surface. Through the walls were built the necessary ore-chutes and manways.

In the Creighton, the methods of mining resemble those formerly used at Crean Hill, except that the walls and filling consist entirely of ore, which forms a large reserve of broken material in the event of any emergency arising.

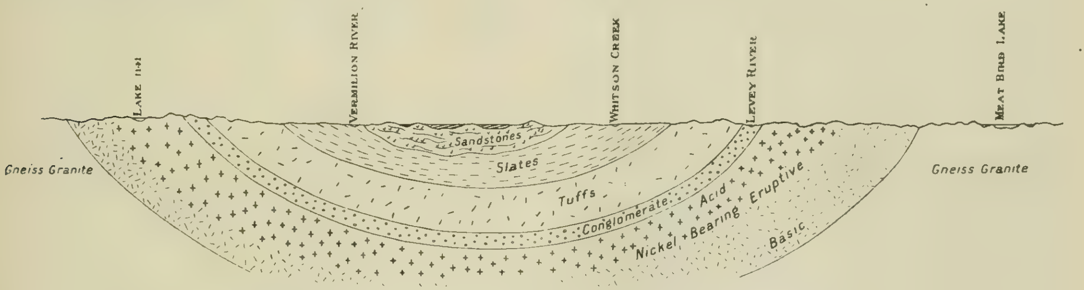
In the Murray mine a system of mining which is new in the district is being evolved. Its progress will be followed with considerable interest as development proceeds.

Metallurgical Practice.—Each of the three large mining companies now operating at Sudbury has its own metallurgical plant. That of the International Nickel Co. is situated at Copper Cliff, that of the Mond Nickel Co. at Coniston, and that of the British America Corporation near the Murray mine, at the new settlement, Nickelton.

while that of the Mond Nickel Company goes for treatment to Swansea, Wales.

At the British America Co.'s plant the ore is not roasted but is treated direct in blast-furnaces, where a matte carrying about 10% of copper and nickel is produced. This is re-smelted in converters as at the other smelters to produce an 80% matte which is shipped to refineries at Deschenes, Quebec.

At Copper Cliff the roasted ore usually contains from 10% to 11% of sulphur. From 9,000 to 10,000 lb. of roasted ore is required for a charge to which is ordinarily added 2,000 to 3,000 lb. of green ore. The latter varies in amount, depending on the quantity of sulphur it and the roasted ore contain. Furnace scrap is added and quartz as flux, which varies in quantity from nothing to 2,000 lb., according to the silica in the ore. The quantity of coke added to the charge is adjusted to a certain percentage of the weight of ore and flux, and varies from 10% to 12%.



Geological Section across the Sudbury Nickel Basin.

The process at the first two plants is practically the same; that of the last-named somewhat different.

Needless to say, in operations of such magnitude as are pursued at Sudbury, it is obvious that all the plants are comprehensive, extensive, and fully equipped with the latest machinery and appliances to meet their several requirements.

At the International Nickel Co.'s plant, and at that of the Mond Nickel Company, the ore is roasted in open heaps to remove part of the sulphur. The roasted product is smelted with a variable amount of green ore, flux, and coke to produce furnace or standard matte. The latter is blown in standard converters to make a matte of 75% to 80% of nickel and copper. The matte from the Copper Cliff converters is shipped for final treatment—the separation and refining of the copper and nickel—to the refineries of the International Nickel Co. at Port Colborne, Ontario, and in New Jersey,

In the converters, quartz and silicious ore is used to flux the excess of iron and bring the matte up to the required percentage in copper and nickel.

The International Nickel plant has eight blast-furnaces, four of which are now in operation. All are of the rectangular water-jacketed type. Five measure 50 in. by 204 in. inside the tuyeres, are 19 ft. high from the hearth plate to the charging floor, and are rated at 500 tons per day. The three other furnaces are of the same style but somewhat larger, having inside measurements at the tuyeres of 50 in. by 300 inches.

In addition to the blast-furnaces the company has one reverberatory furnace for treating flue dust and green ore fines. The furnaces are 112 ft. by 19 ft. hearth area. The roof is 20 in. thick for the first 35 ft. near the coal burners and 15 in. thick for the rest of the way. The extreme height inside is 6 ft. The bottom is composed of fine crushed quartz, well fritted.

The spring of the roof arch is 19 in., 1 in. rise to the foot.*

The most interesting feature in connection with the reverberatories is the use of extremely finely comminuted coal dust as fuel, which is propelled by an air-blast in the form of a spray of dust and which burns as readily as fuel oil.

The International Nickel Company has six basic converters, each 37 ft. 2 in. long by 10 ft. in diameter, outside measurement. They run on four tread rings, 12 ft. in diameter. The stack or opening in the roof for the escape of gas is in the centre of the cylinder. There are 44 tuyeres, $1\frac{1}{4}$ in. in diameter and 7 in. apart. There are no tuyeres directly under the stack. The length inside the lining is 33 ft. 3 in. The bottom is 2 ft. thick, the back or tuyere wall is 18 in., and the front 15 in. thick. The roof is a 12 in. arch. The brick directly round the tuyeres is 18 in. thick.

Experiments having for their object the utilization of pyritic smelting at Copper Cliff have not been successful.

The maximum capacity of the 8 blast-furnaces and the one reverberatory of the Copper Cliff plant amounts to 100,000 tons of ore per month and of the converters to about 33,000 tons of furnace matte charged.

The plant of the Mond Nickel Company follows the same general lines as the one just described, and the equipment involved and the process followed are similar. Reverberatory furnaces are not employed. The maximum capacity of the four blast-furnaces amounts to 45,000 tons of ore monthly, and of the three converters to 10,000 tons of furnace matte charged.

The British America Corporation has two blast furnaces, each being made of steel water-jackets 14 ft. long resting on the crucible, with forty-eight $4\frac{1}{2}$ in. tuyeres. Each smelts from 14,000 to 16,000 tons of ore monthly and has a maximum capacity of about 17,000 tons. Each measures 50 in. by 360 in. inside the tuyeres and is 16 ft. deep from the feed floor to the bottom of the crucible. Special charging cars with four compartments of 8 tons each, with weighing device and drawn by electric locomotive, have been provided.

The plant has three basic-lined Peirce-Smith converters measuring 30 ft. by 13 ft. external measurement, with 44 tuyeres, each $1\frac{1}{2}$ in. diameter. Each converter is rotated electrically and equipped with a Garr silica charger. Two 60 ft. span electric travelling cranes, capable of lifting 40 tons, are provided.

* See A. P. Coleman, "The Nickel Industry," Canadian Dept. of Mines, 1913.

Air for the blast-furnaces and for the converters is given by Rateau Smoot turbo-blowers, driven by steam turbines. There are two of these for the furnaces, each giving a blast of 30,000 cu. ft. at 40 oz. pressure, and two for the converters with a blast of 36,000 cu. ft. each, at 12 lb. pressure. This high pressure permits the necessary rapid conversion of the matte from the blast-furnaces which is lower in nickel-copper content than that sent to the converters at the International Nickel or Mond Nickel plants where, as mentioned before, the ore is mainly roasted before being sent to the blast-furnaces.

Power for the plants of the International Nickel Company and the Mond Nickel Company is provided by hydro-electric developments on the Spanish River, about 23 miles west of Copper Cliff station, and from smaller falls on the Wahnipitei and Vermillion Rivers. The British America Nickel Corporation is at present using steam power, but it is hoped electric power may be utilized here also in future with the tapping of additional sources of hydro-electric energy.

Nickel in South Africa.—In the *South African Journal of Industries* for June, Mr. T. G. Trevor, Inspector of Mines, gives information relating to a new discovery of nickel in South Africa, on the property of the Scotia Talc Mining Co., in the Barberton district. The geological formation here is that of the Jamestown series of schists, the actual horizon being that of the Lily Bar. The work done consists of one main quarry about 12 ft. deep, and four or five small cuttings which expose the outcrop for some fifty yards. The exposure here shows a bed 2 ft. 3 in. in thickness, dipping conformably with the formation at an angle of about 60° to the south. The bed is highly stained with a green mineral, and obviously contains a large percentage of granular magnetite. The high specific gravity of the rock is immediately noticeable. The hanging wall is a fissile sandy rock, which might be described as a phyllite. The foot-wall is a decomposed sandy rock, also shaley in structure and showing some green stains. The report of the Government Chemist on a selected sample of the main bed was as follows: In order to preserve the specimen only a small portion chipped oft the end was analysed. This contained 25·8% of metallic nickel. As sulphur and arsenic appear to be absent, the ore is probably a mixture of magnetite and a nickel silicate. Its specific gravity is 4·49. It is almost totally insoluble in acid.

WAR EXPERIENCES IN RUSSIA.

By DR. A. L. SIMON.

The author continues his account of his experiences in Russia and Siberia during the war. Previous articles have been published in the issues of April and October of last year.

IRKOUTSK, where I arrived in April, 1916, was then a very quiet and orderly town. No concerts at the hotels, no gipsy bands, no theatre, just a couple of cinemas chiefly displaying propaganda plays. Hotel accommodation was difficult to obtain, a large number of rooms being occupied by representatives of the Swedish Red Cross, the American Y.M.C.A., and American Red Cross Nurses, all of whom had special missions in connection with camps of prisoners of war in and near Irkoutsk. All of them were real Samaritans and fulfilled their difficult task in a most praiseworthy manner, with incredible personal sacrifices and abnegation. One of the Swedes down with spotted typhus was being carefully nursed by American sisters. An American gentleman, Mr. Bartholomew, by his tact and courtesy had gained the full confidence of the Russian authorities to such an extent that whatever he asked for was certain to be granted. Streets and shops, which in pre-war days always presented a most animated appearance, were practically deserted and did not seem to be needed. Possibly the last weeks of Lent were partly responsible for this state of things. Certainly the terrible losses sustained by the Siberian regiments had spread gloom and mourning into every family, creating an intense feeling of sadness.

Visits to Mines near Irkoutsk.—My presence in Irkoutsk was due to professional work. Five copper mines and one mica mine, the owners of which resided in Irkoutsk, were to be investigated. The journey to the mica mine was easily dispensed with, inasmuch as the owner refused to show it. His excuses were numerous, bad state of the roads, snow and ice, even a landslide which obliterated all former workings. There were really so many excuses that in all probability the mine solely existed in the imagination of the would-be seller. The owner of the copper mines, a former police official, was well provided with documents, samples, and marvellous tales as to the untold riches of his mines. They were all situated in the Buriat country, in the middle reaches of the river Ouda. It would take three days to get there, a fortnight to see the mines, and as Easter week was close at hand, Easter week when nobody did any work in Russia and when neither horses nor carriages were procurable from the peasants, he maintained that it was imperative to postpone our departure from Irkoutsk for at least a fortnight. A pleasant prospect in that part of the world. He would, however, see that time should not drag, and he would make all provisions for a record

On the Okha River.

journey when we did start. In the meantime there were many dinners and meetings at which he was most confidentially communicative. He knew of the responsibilities of a mining engineer, and he appreciated very much that the Petrograd financiers had sent such an experienced and serious man to investigate the merits of his mines. Besides the copper mines he also owned coal mines, coal mines with coal exceptionally rich in by-products. He was told this by the professors of the Petrograd School of Mines. He did not know anything about the value of such by-products, and he would welcome the co-operation of a scientific partner in this undertaking. He would like me to be this partner, and he would gladly pay 100,000 roubles for such co-operation. He was, however, a poor man, but expected to realize a large sum of ready cash from the sale of the copper mines, the merits of which were beyond question. As soon as that sale was completed, he would be prepared to pay 50% of the co-operation money. A beautiful scheme so alluring that he readily complied with my request to give it in writing. I forwarded this document for safe custody to my principals in Petrograd, adding that, on the face of it, I should not be surprised to find the copper mines to be valueless. Needless to say that was the case.

The journey to visit them was, however, a most interesting one. It started from the station of Bada, situated on the Trans-Siberian, led through Buriat country most of the way, and eventually rejoined the railway line again at Onochoi. The river Ouda had to be crossed twice. On the first occasion it was still partly frozen, but there were open channels some 15 ft. wide near each bank. These were bridged over with poles from field fences on one side and with a ladder and planks from a Buriat settlement on the other side. To have arrived safely on the other side was a real relief, as the river might have broken up any minute. As a matter of fact the ice-flow started two days later, and on re-crossing the river on the return journey, dug-outs had to be used.

The mines visited were the following: Korka, Ulan-Burgass, Kungutt, Tar-Bagatai, and Angir-Khan. All of them are mentioned in Reutovski's book on the geology of Siberia. They are described as old prospects for copper, lead, and iron, and had been located in 1840 or thereabouts by the administration of the government - owned ironworks of Petrofski Savod, while scouring the country for an appropriate supply of iron ore for their blast-furnaces. The mines were sufficiently prospected in those days to show their deficiency as regards quantity and quality of ore. They were taken up again by the owner with whom I had to deal in the belief that he could effect a ready sale to kindhearted foreigners.

One of the mines, the Angir-Khan, on the river Angir, I found particularly interesting from a theoretical point of view, as it afforded a perfect illustration of the genesis of an ore deposit on a miniature scale. The Angir river which runs from west to east is bordered on its southern bank by a series of spurs running almost due north and south. One of these spurs, some 500 ft. high, is intersected by an iron lode 20 to 30 ft. thick, the lode being almost parallel to the ridge of the spur. Copper stains are readily discernible on the eastern side at about 50 ft. below the ridge. A small drive started a few feet lower down the hill, after passing through limestone, intersects a few stringers of malachite, $\frac{1}{4}$ to $\frac{1}{2}$ in. thick, and finishes in an iron ore containing sulphides. Above the level, the iron ore is completely oxidized and porous, while in the drive and below it the iron ore is compact and shows crystals of iron and copper pyrites. It is therefore evident that the copper deposit is due to the leaching by atmospheric influences of the copper contents from the upper portion of the iron vein, the copper in solution being precipitated on coming into contact with the limestone. It is even possible by ascertaining the cubic contents of that upper portion to estimate approximately the amount of copper which has been leached out. Such an estimate shows the absolute futility of ever finding a copper mine in that locality. On a previous journey to Siberia in June, 1914, I found an almost identical copper deposit on the shores of the River Abakan, an affluent of the Yenesei, on which a Russian geologist had spent some £20,000 in useless prospecting.

THE BURIATS.—The most interesting feature of that journey, however, was my experience of the Buriats, who are strict adherents to the faith of Confucius, and derive their religious teachings straight from the Lamas of Thibet. Without exception they were extremely hospitable, and always gave me access for a night's rest to their scrupulously clean best room, wherein resides in a glass case a gilded statue of Buddha and various of his relations. In front of the glass case numerous offerings to Buddha such as sugar, tea, cereals, etc., stand in cup-shaped receptacles made of choice Chinese cloisonné, or chased copper inlaid with brass ornamentations. All these dishes placed in a row are flanked at either end with a spouted receptacle of similar workmanship, containing liquid offerings the nature of which I did not ascertain. We also noticed a long narrow box, lavishly decorated, which contained, painted on rice paper, various prayers left by Lamas while on touring visits. The quaintest of all, however, is the praying box, a small closed cylinder similar in decorative design to the cups containing offerings. A second cylinder, on which the standard prayer

A Buriat Postman and his Daughter.

is written, is enclosed. The latter is fastened to a spindle which protrudes through the lid of the praying box. By giving a twist to the spindle, the inner cylinder spins round and round, and each revolution thereof is equivalent to the saying of what may be termed the standard prayer. Whoever of the household passes Buddha's shrine gives a twist to the spindle and thus fulfils his or her devotions in a most expeditious manner. Thus are the mechanics of the roulette applied to some religious use.

Large Buddhist temples have been built in six or seven localities in the Buriat country. No women are allowed near them, the work of cleaning and cooking, etc., being done by the apprenticed Lamas, all clad alike in reddish brown kaftans. When we visited one of the temple localities, the Lamas did not show themselves, as they evidently did not wish to have any intercourse with Russians, one of our party unfortunately being in the uniform of a railway official.

At one of the Buriat houses where we resided for several days, and the railway official having left us by then, our stay seemed to arouse the curiosity of the neighbourhood for miles round. Visitors flocked in from all parts and wished to see and shake hands with the Englishman. This seemed at the time a mystery, and it was only several months later that I hit on a satisfactory explanation. On leaving that Buriat house its owner, an old Buriat, asked to be allowed to personally drive

A Buriat Temple.

to our next stopping place. After a journey of about two miles he requested us to alight and led to two graves, both built of brick, whitewashed and covered with cast-iron plates. One of them bore a Latin, the other an English inscription. They were dated 1833 and 1839, and referred to Sara Stallybrass and Charlotte Stallybrass respectively.

The old Buriat told me in very bad Russian a long tale which seemed so strange that I could not follow it. Several months later, I met Mr. Walter Davidson at Ekaterinburg, the best friend of every Englishman or American who ever visited the Urals or Siberia, and the finest representative the British Government could ever have had in those parts. He was the head of the British Bible Society's Office for Eastern Russia and Siberia, and he, of course, knew all about Mr. Stallybrass and the graves. Suffice it to say that Mr. Edward Stallybrass was a missionary who settled amongst the Buriats in 1830. After two years' residence he translated the Bible into Buriat, and his translation is the one in use to this day. While among the Buriats he lost two wives, buried in the above-mentioned graves. He never attempted to convert the Buriats by words, but he showed them by his example of living and by ministering to their needs and ills that his creed was superior to theirs; he had their good will, and held their admiration which lasts to this day and is being handed down from generation to generation; it is still revealed by their paying special respects to a visiting Englishman.

The Russian authorities, and particularly the Russian Church, resented Stallybrass's popularity and rising power. They requested him to leave hurriedly. He went, but he left on the two graves standing in a lonely part of Siberia two monuments to the grit and perseverance of real missionary work of which every Englishman may justly feel proud.

On the return journey I visited the coal prospects on the river Okha, some 160 miles west of Irkoutsk. The coal is a brown coal of good quality and easily worked. The production of other coal mines in the neighbourhood is, however, more than sufficient to supply present needs, and there is no special inducement in spending capital in a new competitive venture.

VERCH ISSETSK.—My next stopping place was Ekaterinburg, where I remained for several months investigating during that time the Verch Issetsk Estate. This is situated in the Ural Mountains directly to the north of the town of Ekaterinburg. It covers an area of 1,059,638 acres. The total surface of workable timber lands amounts to 758,773 acres. This is sufficient to yield all constructional timber required by the estate and further to yield 79,000 cubic fathoms of wood for the production of charcoal. The latter amounts to 215,000 baskets per annum, which quantity is sufficient for a production of about 80,000 tons of finished iron products such as sheet iron or mild steel in the shape of bars, bands, etc. Besides the wood and charcoal the estate owns an important concession for coal near the village of Jegorgina, readily accessible by rail. This coal is an anthracite of good quality. The use of this fuel for the reduction of the iron ores opens quite new issues as regards an increased future iron production which hitherto was limited by the available charcoal.

Mention must also be made of the possibility of obtaining coke of good quality from the centre of Siberia, namely, from the coalfields of Kousnetsk, those of Cheremkovo, and others. This coke can be delivered in the Urals at a price of about £2. 10s. per ton. Such new supply of coke, which in all probability will be available when things are again normal, will give a fresh stimulus to the iron industry of the Urals in general and also to the iron production of Verch Issetsk on account of its extremely favourable situation as regards communications.

The total reserves of iron ore on the estate are estimated to amount to 6 million tons, of varying quality and composition. There are three distinct kinds of iron ore: those with high contents of iron from Vuisoko Gora containing about 60% of metallic iron, those known as surface ores from numerous localities in the estate containing from 45 to 52% of metallic iron, and those of the Sinarne deposit, not yet being worked but containing an ore of extreme purity with 55% of metallic iron. The ores mentioned are in no way all the iron ores of the estate, for other deposits as yet undeveloped are known to exist. As regards the deposit of Sinarne, which has been prospected within recent times, no reserves can be mentioned. It is a deposit of great importance, and other Ural estates have obtained concessions in that locality also.

The ironworks have been built in the village of Verch Issetsk, situated at about ¾ mile to the north-west of the town of Ekaterinburg. The works consist of a blast-furnace, Ural type, two small and one large Martin furnaces with basic lining, a small rolling mill for the rolling of billets for sheet iron, and a rolling mill for sheets, with a small installation for the manufacture of galvanized iron sheets. In normal times the Martin furnaces are fed partly with the pig iron from the blast-furnace of the Verch Issetsk works, but chiefly with the pig from the other blast-furnaces of the estate. The details of these pig supplies during 1915 are as follows: Rejefskoi 6,000 tons, Utkinski 7,000 tons, Nijni Rudianski 9,000 tons. The Verch Nevinsk furnaces provided no supply that year. This small production was due to the temporary scarcity of labour. Besides the centres of production mentioned, there are others which were not working owing to war conditions.

There are three kinds of copper deposits on the estate, namely:

(*1*) The deposits of Pishminsky (vein formation).

(*2*) The deposits of Kalatah and neighbourhood (lenticular deposits).

(*3*) The deposits of Rudianka (contact deposit).

The last of these was worked many years ago, but no details are available, and the workings are inaccessible.

The Pishminsky deposits have been worked since 1909, and are fairly well developed. They consist of impregnations in schists with vein characteristics; in places small veins of clean chalcopyrite are found. There are at present four working centres which extend over a length of about 7 miles, and are being worked through the shafts mentioned in the following table. Ore reserves and assay-values are given for each shaft.

Shaft	Ore reserves Tons	Assay-value %
Ivanofsky	25,000	5
Central	25,000	6
Alexandrofsky	40,000	3·5 to 4
Klutchefskoi	being developed	

Generally speaking the development work in these shafts, as also in the other copper mines, is not in keeping with their importance. The ore contains sufficient gold to make its extraction a remunerative one, but in order to derive all advantages therefrom it would be essential to have an electrolytic refinery.

The deposits of Kalatah and neighbourhood are the most important ones of the estate, and are undoubtedly of considerable value. These deposits may be grouped along three main lines all running north and south. The first of these lines, the eastern one, passes through the deposit of Kalatah and comprises the deposits of Kalatah, Abnavlione, Kovelionovoe, Ruminskaia, and Bielorejinsky. The distance from this latter deposit to that of Kalatah is about 6 miles. The four deposits first named are all within the first mile from Kalatah. From Ruminskaia to Bielorejinsky the surface consists of deep marshy peat soil and has not yet been explored. The second line passes through the deposit of Jegoffski at about 6 miles to the west of Kalatah. This deposit has been worked in former years. Little is known of it, and it requires to be explored afresh. The third line passes through the deposit of Karpuchino at about 10 miles to the west of Kalatah. On that line two deposits are being worked.

All these deposits consist of lenticular ore-bodies of iron pyrites intermixed with copper pyrites, the amount of copper varying from 1 to 8% in the ore. All the lenses are covered with an iron capping of limonite. At a shallow depth iron pyrites without copper contents is found, the copper evidently having been leached. At varying greater depth the mixture of the iron and copper pyrites is found. In the Kalatah lens the ore has been leached to a depth of 20 fathoms, at which level the first indications of copper appeared. The mine had, however, been worked in olden times to the 51 fathom level, at which the present new workings were started. At Bielorejinsky and at Karpuchino the copper contents are found closer to the surface. The development of the lenses is not in keeping with the importance of these deposits, a policy of misplaced economy, as in so many other Russian ventures, being chiefly responsible for this lack of enterprise. The lenses of Abnavlione and of Bielorejinsky, there being three in the latter locality, are easily accessible and appear to be for the time being the most likely ones to create ore reserves.

The ore reserves to be taken as proved are the following: Kalatah, 500,000 tons averaging 2·5% copper, of which 80% may be reckoned as recoverable; Bielorejinsky, no accurate details available but estimated to contain 9,000 tons of copper recoverable; Karpuchino, 200,000 tons averaging 2·5 to 4%; Pishma estimated to contain 3,400 tons of recoverable copper.

While no quantities can be mentioned as probable ore, the conditions obtaining at the deposits of Abnavlione and Bielorejinsky are such that one cannot doubt of the existence of important ore reserves. Furthermore, new deposits may reasonably be expected on all of the three lines mentioned.

At Pishminski, the metallurgical installation comprises: 1 Humboldt water-jacket blast-furnace, 1 reverberatory furnace of the Ural-Martin type, 2 converters, and 1 small refining furnace. The installation is a compact one. The removal of the granulated slag from the water-jacket and reverberatory furnace deserves to be specially mentioned as it is an extremely ingenious device working at low cost. The slag is granulated by water injection, stored in hoppers, and removed to the dump by aerial ropeway.

Unfortunately the whole of the Pishminski works have no reason for existence. In 1915 the cost of the copper at these works amounted to £75 per ton, while at the Kalatah plant, which did not work to its full capacity, the copper only cost £56. The chief cause of this difference is found in the fact that 10 to 11% of coke is used in the water-jacket furnace at Pishminsky, while at Kalatah only 1% is required.

It must be mentioned that both Karpuchino and Bielorejinsky ores contain gold and that Pishminsky ore is auriferous as well. The copper from these works is cast in anodes, while the copper from Kalatah is cast in bars. The whole of the copper from Verch Issetsk estate is, however, auriferous, and the product from Kalatah could be sufficiently enriched by an admixture of auriferous quartz available on the estate so that all the copper should be subsequently refined locally. This was not being done owing to war conditions. All the smelting should be carried out at Kalatah.

The metallurgical plant at Kalatah is as near perfection as one can wish to see and the work done could scarcely be better. The plant was designed and was being worked by Mr. F. W. Draper, an eminent Canadian metallurgist of great judgment, foresight, and efficiency. The works consist of: 2 water-jacket blast-furnaces, 2 converters, and 1 refining furnace.

The water-jacket furnaces yield a matte of 11% copper. It is collected in a settler and periodically tapped into a 5-ton ladle, in which it is lifted and transferred into the converter. After five successive fillings, each of which is blown for 45 minutes, the converter contains black copper, which is transferred by means of a second ladle to the refining furnace, from which, after the usual treatment, it is hand-ladled into the bar moulds. This continuous series of operations is conducted without any superfluous handling and without allowing any of the intermediate products to cool down.

During my visit the installation was not working to full capacity on account of a shortness in the supply of ore. This deficiency was accounted for by scarcity of labour, again due to war conditions.

The Verch Issetsk Estate conducts other operations in addition to those before mentioned. A sulphuric acid plant is capable of producing 1,200 tons of acid yearly. There is a small cyanide plant for the extraction of gold. This plant has been erected for the treatment of the iron cappings of the Bielorejinsky mine, the annual yield being about 3,500 oz. of gold. The gold placers of Kirgirskaia are estimated to contain some 20,000 oz. of gold which could be won by dredging. An important source of income, though of a temporary nature, was the sale of iron pyrites to sulphuric acid works. Of late the price of iron pyrites had increased so considerably that the sale of that commodity yielded very handsome profits. This was due to the impossibility of importing for the time being pyrites from Spain, and it may be anticipated that the high price will prevail even long after the war. The profits realized from this source amounted in 1916-17 to about £100,000.

The foregoing summary of the operations of the Verch Issetsk Estate shows it to rank among the best of the Ural properties, and one can only wish and hope that political unrest will soon disappear and enable the various Ural properties to become active producers once more.

NEWS LETTERS.

TORONTO.

July 12.

COBALT.—The strengthening in the price of silver coupled with the prospect of further advances has resulted in increased activity in the Northern Ontario silver districts. Shippers, however, are still disposed to store their bullion for the present, rather than accept current quotations. The Ontario Bureau of Mines has undertaken a re-survey of the geological conditions of Cobalt, as it is believed that the extent of underground development carried on since the issue of the first survey will add very considerably to the value of the work as a guide to operators and prospectors. The survey is in charge of Cyril W. Knight, assistant provincial geologist, and is expected to be completed this year. During June, the Nipissing mined ore of an estimated value of $200,449, and shipped residue from Nipissing and custom ores of an estimated net value of $109,746. No bullion was shipped. On the Colonial, which was recently reopened after being closed for many years, some rich ore has been encountered in sufficient quantity to justify the expectation that the mine will shortly take its place on the list of shippers. The geological conditions are similar to those of the rich O'Brien mine adjoining. The La Rose Consolidated has blocked out a large ore-body stated to be 120 ft. long by 15 ft. wide on the University property, which carries 38 oz. to the ton in addition to some high-grade ore. Two new veins are being developed on the original La Rose. The Kerr Lake has latterly shown a considerable decline in production, the output for May being 48,834 oz. of silver, as compared with 61,512 oz. in April and 99,398 oz. in March. The company has contracted with the Dominion Reduction Co. for the treatment by the latter of between 75,000 and 100,000 tons of low-grade milling ore. The mill of the Peterson Lake has been obliged to close down owing to a shortage of power. The Victory has increased its capital from $500,000 to $2,000,000. The shaft on the Oxford-Cobalt has reached the 150 ft. level, and cross-cutting has been begun to tap the vein. Work has been resumed at the Ruby Silver property, closed since 1907.

PORCUPINE.—The labour situation shows some improvement, but the operations could give employment to many more men if they were available. At the annual meeting of the Dome Mines held on June 18, President Bache stated that it was not proposed to increase the dividend rate, as surplus profits would be devoted to the reduction of capital. The Hollinger Consolidated is treating 1,700 tons of ore per day and it is not expected that this rate will be materially increased for some time. A statement covering the period from January 1 to June 2 shows an income of $2,879,706, as compared with $2,822,858 for the same period last year. Net profits were $1,431,685, as compared with $1,315,798. The Davidson has let a contract for the sinking of a four-compartment shaft to a depth of 1,000 ft. The workings have now reached a depth of 600 ft., with good tonnages of ore opened up at the various levels. The Porcupine Vipond-North Thompson has had an examination made of the mill with the result that an estimated amount of $50,000 will be required to enlarge and improve the plant, giving it a capacity of 150 to 160 tons per day. A meeting of shareholders has been called to authorize the necessary financial arrangements. The Dome Lake mine has been closed down.

KIRKLAND LAKE.—This district has for some time been handicapped by the high operating costs, which rendered it unprofitable to mine ore of as low a grade as that successfully treated at Porcupine. This difficulty is being gradually overcome by the introduction of economical methods of mining. At the Kirkland Lake mine costs have been reduced to an average of under $7 per ton, as compared with $8 and $10 a few years ago. The Teck Hughes has achieved even better results, having reduced costs to about $6 per ton. It is operating at about two-thirds capacity, treating approximately 2,400 tons of ore per month, finding that by working at this rate higher efficiency can be maintained than by endeavouring to run at full capacity. Work has been started on the excavation for the mill of the Ontario-Kirkland. It is planned to have the foundations completed before the winter sets in. Development on the 450-ft. level is meeting with highly satisfactory results, the ore showing improvement as compared with the upper levels. The Lake Shore during May produced $41,187, from the treatment of 1,636 tons of ore, being an average recovery of $25·18 per ton. Preparations are being made to sink the shaft to a depth of 600 ft. or more. Good progress is being made with the construction of the mill of the Wright-Hargreaves. The heavier parts of the machinery are now being installed. The main vein of the Bidgood has been cut at the 200-ft. level, where it was a width of about 15 ft. as compared with 12 ft. at the 100-ft. level. A vein of about 10 ft. in width has been opened up in a dyke of porphyry formation on the Wood-Kirkland property.

GOWGANDA.—Additional discoveries of importance have been made on the Castle property of the Trethewey. The vein recently found near the lake has been sunk on and is yielding rich high-grade ore. Another vein has been discovered, running directly under the office of the company. The success of the Trethewey has given a great stimulus to development and many new properties are being opened up. The Big Four, the plant of which was recently destroyed by a bush fire, is getting in new machinery. The mill of the Reeves-Dobie is treating about 25 tons per day and will be enlarged to a capacity of 50 tons daily. A rich discovery of silver is reported on the Thompson group of claims in Van Hise township.

CAMBORNE.

EAST POOL & AGAR.—What appear to be quite important discoveries of high-grade ore have been recently disclosed by developments in this company's properties. As stated in my letter in the April issue, a cross-cut is being driven north from a point in the old workings on the 252 fathom level to intersect the Rogers lode at that depth. In the course of this work, Branwell's lode has been met with, and at the intersection the lode was 5 ft. wide and assayed 70 lb. of black tin per ton by vanning assay. At the same level, a cross-cut south was also started to make a direct roadway to the shaft, and this has intersected the Red lode, reported to be also 5 ft. wide and worth 45 lb. black tin per ton. Both these lodes in the level above showed only indifferent values, so that these developments are both highly encouraging. Then, again, in the great 255 fathom tunnel, being driven from Agar shaft toward the Tolgus mines with a view to testing the Rogers lode in those properties, and at a point 890 ft. from the shaft, what is probably the Great lode was encountered; a cross-cut through the lode disclosed ore averaging 150 lb. wolfram and 8 lb. black tin per ton over a width of 13 ft. Since this news was officially made public, the black tin values have substantially improved, and I hear at the time of writing that the end assays over $1\frac{1}{2}$ cwt. per ton. The Great lode was exceedingly productive in the East Pool section of the property and has been most extensively worked there, but it has not previously been seen in the Agar section. The discovery, therefore, is one fraught with great possibilities, and its development will be watched with the greatest interest. These results indicate the value of systematic development, and it is a thousand pities that some of the neighbouring mines have not the capital available to carry out similar exploratory operations, for there can be no doubt that the expenditure would be justified up to the hilt. I understand that the stamping capacity of this company's plant is being substantially increased, and certainly the ore reserves appear to warrant this course.

SOUTH CROFTY.—The erection of the Mineral Separation's testing plant for the flotation treatment of this mine's complex ores is now being proceeded with. The result of these tests is being awaited with much curiosity, and it is hoped that the management will be frank about the results of the experiments. The results at East Pool were most encouraging a year ago, but nothing has been heard of late of any further work.

Recent developments at South Crofty have been excellent, but nothing has officially been made public, and I would suggest that the directors, in the interest of the shareholders, and indeed of Cornish mining generally, should take an early opportunity of making the facts public.

GOVERNMENT FINANCIAL ASSISTANCE.—Yet a further deputation has waited on Sir Robert Horne, the President of the Board of Trade, with a view to securing financial assistance, or reparation, for the industry. Although this deputation was headed by the Lord Lieutenant of the county, supported by the local members of Parliament and by prominent members of the industry, no better success was met with than on the former occasion; indeed, it was time and money wasted, as might have been anticipated from the nature of the communication from the President when agreeing to receive this second deputation. It is good to know that Mr. Oliver Wethered—whose faith in the success of these deputations was never more than lukewarm—has now publicly made known that he is firmly determined to waste no further time in endeavouring to move the Government to reconsider its attitude, and that he urges all concerned to direct their thoughts and energies to solving their own problems. There can be little doubt that the publicity given to these efforts to secure Government financial assistance for some of the mines has done much harm to those concerns not seeking such help, and any further attempts will only tend to increase the mistrust of the investing public in all West of England mining ventures. Mr. Wethered speaks with authority as the new President of the Cornish Chamber of Mines, and it is to be hoped that his advice will be followed. No one knows better than himself of the possibilities of Cornwall as a mining field, given adequate capital and well-directed development, and the Chamber might now usefully concentrate on a publicity campaign to secure a renewal of confidence which will lead to the provision of fresh capital for the industry.

SUGGESTED TIN PRODUCERS' ASSOCIATION.—The valuable suggestion made by the enterprising manager of East Pool & Agar (Mr. M. T. Taylor) that an effort should be made by the Cornish Chamber of Mines to bring the world's tin producers together for the purpose of seeing if an agreement could be made for fixing a minimum price for tin was adopted by that organization at the recent annual meeting, when a resolution was passed in the following terms: "That this Chamber, believing that the very great variations in the price of tin are brought about largely, if not mainly, by other forces than the law of supply and demand, is of the opinion that the time has come when tin producers should see what steps can be taken to secure a minimum price for the white metal. It considers that the basis of the British Metals Corporation that the price of £280 per ton is below the average cost of the world's need is a sound one, and having been informed of a recent meeting at Singapore for consideration of the question of such minimum price, hereby notifies the Nigerian Chamber of Mines and the Federated Malay States Chamber of Mines (London) to appoint representatives to confer with representatives of this

Chamber for the consideration of the whole question and what steps should be taken to secure the desired end." If some arrangement can be come to that will check the wild speculation of the past year, it will be an important step for the stabilization of the tin-producing industry.

MINISTRY OF MINES BILL.—In spite of the opposition of all the parties concerned—capital and labour alike—to this Bill, and in defiance of an adverse vote in the House of Lords, the Government seems determined to put it on the Statute Book, and this being the case, we are glad to see that representations, made with a view to securing the compulsory appointment of a committee under this Bill to advise the Minister of Mines respecting the non-ferrous mining industry of this country, as advocated in the last issue, were successful. The terms of the appointment of this committee have not yet been made public, but no doubt West of England mining interests will be adequately provided for.

CALLOOSE TIN MINES & ALLUVIALS.—The shareholders' committee of investigation has now reported on the result of its labours. In support of the Magazine's consistent adverse criticism of this concern, an extract from the committee's summing up of the position, as given in their report, may be here quoted: "A number of material statements in the prospectus were false, while others were grossly exaggerated, and, so far as they are from reports to the directors, your committee feel that the directors signing the prospectus had no reasonable ground to believe the statements were true." Further comment is superfluous at present, but another occasion may arise.

CAMBORNE SCHOOL OF MINES.—The eighteenth annual Students' Dinner was held at Camborne on July 2 last, when a most interesting evening was spent. It was the first dinner since 1914, when the late Mr. J. J. Beringer was Principal. The Chairman, Mr. R. P. Castier, spoke in glowing terms of the late Principal, and also gave the newly-appointed Principal, Mr. Alex. Richardson, a very hearty welcome. As an old C.S.M. man and as one who has had wide experience in the various branches of mining, Mr. Richardson's coming has proved very acceptable. Throughout the year he has worked untiringly for the third-year men, with whom he has had much to do, and it is universally hoped that his appointment will result in the school entering into a new era of life and prosperity. Mr. Hutchin's return to the school was also referred to pleasantly.

PERSONAL

R. F. ALLEN is leaving next month for Senegal.

SVANTE ARRHENIUS and Sir CHARLES A. PARSONS have been awarded Franklin Medals by the Franklin Institute, Philadelphia.

T. BALLANTYNE has resigned as general manager in South Africa for the Tati Concessions and has returned to England.

DR. W. S. BRUCE and DR. R. N. RUDMOSE BROWN, together with several directors of the Scottish Spitsbergen Syndicate, left last month for Spitsbergen.

F. C. CANN has been appointed manager of the Geevor tin mine, Cornwall.

R. P. CASTIER has gone to the Ouro Preto company's mines, Brazil.

PERCY CAZALET has retired from full-time employment as one of the consulting engineers to the Central Mining-Rand Mines group. He will live at Nelspruit, in the eastern Transvaal, and will go to Johannesburg for a few days each month.

JOHN CHILTON has been elected president of the Chemical, Metallurgical, & Mining Society of South Africa.

L. MAURICE COCKERELL has left for Mexico.

ARTHUR DICKINSON has resumed mining practice, and has opened an office at Finsbury House, E.C.

A. E. DU PASQUIER has returned to England from the Transvaal.

JOHN DUNCAN is here from Egypt.

DR. C. A. EDWARDS has been appointed professor of metallurgy in Swansea University College.

J. M. EMBLETON has resigned as manager of the South Kalgurli Consolidated and has been succeeded by F. G. BRINSDEN.

C. M. EUAN-SMITH has gone to Burma to inspect the Mawchi tin-wolfram mines. He has joined the board of the proprietary company.

RUDOLF GAHL has left New York for the Cerro de Pasco copper mines, Peru.

F. MORRELL GILDER has arrived from Australia to take up the duties of London Secretary to the Zinc Producers' Association Proprietary, Ltd.

H. W. HARDINGE is here from New York.

J. D. HOFFMANN has been appointed consulting engineer to the Mawchi Mines, Ltd.

E. A. HOLBROOK has been appointed assistant director of the United States Bureau of Mines.

ARTHUR TREVE HOLMAN, of the firm of Holman Brothers, Camborne, was married last month to Miss Ellen Muriel Mills, of Par.

C. E. JORDAN is here from Burma.

F. H. B. LEGGETT is here from Kirkland Lake.

F. W. LEIGHTON is back from Nigeria.

L. J. MAYREIS has renewed his engagement with the Burma Corporation as resident manager in India.

W. S. M'CALLUM is home from British Guiana.

J. B. MCINTOSH has left Utah for Mexico to take up the position of mechanical engineer at Real del Monte, Pachuca.

P. N. NISSEN has returned from Canada.

A. E. PAGE has left England for Chile.

W. A. PRICHARD is here from Colombia.

E. J. PRYOR is expected from Siam.

E. J. RICHES is here from Nigeria.

C. W. ROE has left for Nigeria.

HUGH ROSE, manager of the Santa Gertrudis, Mexico, has been in London on a brief visit.

C. E. ROGERS has returned from South Africa.

J. E. SNELUS is home from Nigeria.

(Continued on next page).

WALTER J. STANFORD has arrived from Krasnoyarsk, Central Siberia.

J. W. H. STUBBS has gone to Algeria for Bainbridge, Seymour & Co., Ltd.

W. E. THORNE has returned from Nigeria and has left for Portugal.

F. H. TONKING has left for the Ashanti mines, West Africa.

G. TRESTRAIL has left for the Kulti Ironworks, Bengal.

HORACE WALKER has left for Johannesburg.

H. S. WEIGALL has arrived at the mines of the Seoul Mining Co., in Korea.

JAMES WHITEHOUSE has been elected president of the South African Institution of Engineers.

A. E. STRICK, mine superintendent at Mount Elliott, died in Arizona during a tour in the United States.

JOHN SOMERVILLE GEIKIE, B.Sc., A.I.M.M., died suddenly of septic pneumonia on July 24 at Bau, Sarawak, at the age of 43. He joined the staff of the Borneo Company in 1902, and was at the time of his death general manager of the company's gold mines in Bau, Sarawak. In 1906, he gained the "Arthur Claudet" prize of the Institution of Mining & Metallurgy for his paper on the Occurrence of Gold in Upper Sarawak. He was the second son of the late Professor James Geikie, of Edinburgh University.

TRADE PARAGRAPHS

HYATT, LTD., of 24, Devonshire Street, London, W.C.1, send us a new catalogue of their flexible roller bearings.

VICKERS, LTD., of Broadway, London, S.W.1, announce that they have opened a depot for Wales and the South-West of England at 43, Park Street, Bristol.

FRASER & CHALMERS ENGINEERING WORKS, of Erith (proprietors, The General Electric Co., Ltd.), send us a pamphlet describing their No. 6 Table Concentrator.

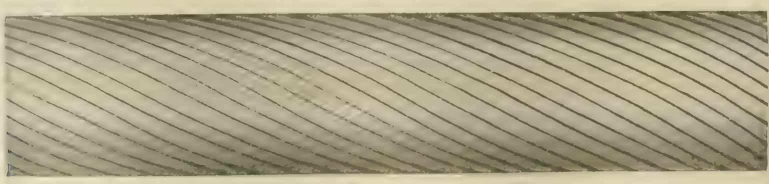
GEORGE F. WEST & CO., of Iddesleigh House, Westminster, send us a pamphlet dealing with the products of the Bucyrus Company and the Western Wheeled Scraper Company.

THE OLIVER CONTINUOUS FILTER COMPANY, of San Francisco, have opened a London Office at 2, Broad Street Place, E.C.2 (Room 193), which will be under the charge of Mr. J. F. Mitchell Roberts.

AGRICULTURAL & GENERAL ENGINEERS, LTD., of Central House, Kingsway, London, W.C.2, announce that they are offering to purchase the control of Henry Bessemer & Co., Ltd., of Sheffield. It will be remembered that the company was formed last year as a consolidation of a number of well known engineering firms. The latest step will provide them with regular supplies of high-class steel.

THE HARDINGE COMPANY, of New York, Denver, and London, send us a number of new sections of their catalogue. These deal respectively with: The principle of the Hardinge mill, the Hardinge ball-mill and its work, the Hardinge pebble-mill and its work, examples of grinding prior to concentration and flotation, information on grinding prior to amalgamation and cyanidation, and the large-diameter, dry-grinding, Hardinge mills as applied to cement and other allied trades. Owing to the increasing demand for mills for handling large capacities, the trunnions upon the 8 ft. and 10 ft. diameter Hardinge mills have been re-designed, having an outer diameter of 27 in. and an inside diameter of 19½ in.

In the June issue of the Magazine it was mentioned that GEORGE CRADOCK & CO., LTD., of Wakefield, had introduced a new form of locked-coil steel rope, called the "Silverlock," the feature of the construction being the prevention of internal corrosion of the wires. The firm have since sent us the following particulars, which, with the accompanying illustrations, will explain the novel features of the new rope: Engineers and all users of wire ropes have in the past, indeed ever since the advent of the wire rope, been faced with the serious and difficult problem of the prevention of rust set up through contact with moisture, saline or corrosive water, hot fumes, and other means. This danger, and often, unfortunately, consequent disaster is present in greater or lesser degree not only in winding ropes, but in all classes and formations of ropes. For instance, in the case of those in use on aerial ropeways, where the inaccessibility of the standing ropes on long spans renders any operation of dressing almost impracticable, it is apparent that there must be a great risk of deterioration. This danger of corrosion is not altogether avoidable even in spite of the best of dressings, and the risk is accentuated obviously according to the use to which the rope is put. It is true that the high standard of quality and construction of the British manufacturer of wire ropes has been a guarantee of excellence and workmanship, and that with the stranded rope, which is composed wholly of round wires,



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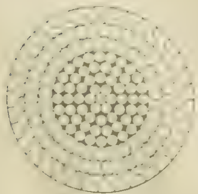

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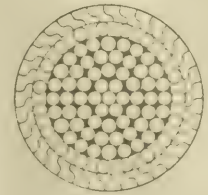

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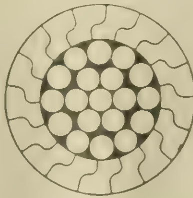


CRADOCK'S "SILVERLOCK" WIRE ROPE.

it has been found fairly possible to deal with the question of corrosion by the application of a suitable composition dressing which should be of the best. In the case of the "Locked Coil" rope, however, where extreme accuracy in the formation of the shaped wires is necessary in order to ensure efficient locking, the same remedy has been impracticable hitherto. It will come as a relief to users of such ropes, therefore, to learn that GEORGE CRADOCK & CO., LTD., of Wakefield, Yorkshire, who were the original introducers and manufacturers of the "Lang's Patent Lay Rope," and are famous for the quality of their goods, have, after much patient experimental and research work, now succeeded in perfecting a new and effective method (against deterioration caused by corrosive action) in the manufacture of their ropes of the locked-coil type. This new process places the firm in a position to produce and offer to their clients a locked-coil rope in which *each separate wire* comprising the construction is coated during manufacture with a heavy layer of metallic covering, thus providing the rope as a whole—after the rope itself is spun—with the much needed and valuable protection required, and at the same time without interfering with the accuracy of section and perfect locking. This development is a matter of great importance to all users of this class of rope, and is being introduced by the firm to their clients under the registered trade name of Cradock's "Silverlock" locked-coil rope. A sample of this rope was exhibited at the recent Royal Agricultural Shows at Cardiff and Darlington, and was received with much interest. The rope is extremely flexible and can be varied in construction to suit the many different working conditions. The accompanying illustrations show the construction of the rope.

METAL MARKETS

COPPER.—There has been a distinctly harder tone about the copper market during the past month, both standard and refined prices having undergone a pretty substantial improvement, arising mainly, it would appear, from the less anxious attitude of the chief group of American producers, who have succeeded in advancing their price for electrolytic to about 19 cents, although it must be admitted that second-hand material is still available at about half a cent less. The quantities of re-sale copper to be picked up, however, seem to have shrunk considerably during the past few weeks, and it may be that consumers both in the United States and abroad will be forced to supply their needs more largely from the dominating group. The only fly in the ointment appears to be the transport congestion across the Atlantic, and also the increased dearness of money there. The difficulty in moving material in consequence of the railway situation is undoubtedly responsible for the very serious falling off in the sales made by the American producers during the second quarter of the year. The restriction is indeed rather alarming, it being stated that for the period April to June the total sales there were only 100,000 tons compared with nearly 300,000 tons during the first quarter of the year, and about 350,000 tons during the period October to December, 1919. There is no mistaking the significance of these figures. On the other hand production in America has been very much depressed, and at the present time is estimated at something under 45,000 tons per month, following about 65,000 per month during the earlier part of the year. In all probability, however, there has been a reduction in the amount of copper awaiting sale in first hands since the end of 1919, and the total at present is believed to be about 180,000 tons, apart of course from copper in process of conversion. The fall in the sterling exchange has naturally tended to stiffen prices of refined in this country, and indeed has been rather a dominating influence. It is thought in well-informed circles that there can be little improvement in exchange during the next few weeks owing to shipments of grain and cotton from America having to be financed, but probably the worst points will be seen before very long, and at the end of the year it would not be surprising if the dollar exchange were up to $4 again. The supplies of scrap metal continue to exercise a marked effect upon consumers' buying here, and also in France, very large quantities still remaining to be disposed of, while there have been big tonnages also in the United States, where the clearing up of the war salvage is proceeding without intermission. Consumption generally, however, shows little response to peace conditions, the attitude of labour being uniformly hostile to increased production, and the result is that works are not able to obtain anything like a reasonable output for the number of workers employed. The strike at the mines of the Rio Tinto Co. in Spain appears still to be in force, and a very large number of men are out; the chances favour an extension of the dispute unless some settlement can be arrived at pretty soon. There are hopes, however, that an adjustment will be rendered possible before long. An interesting point is that the Chile Copper Co. has mapped out a new construction programme which will tend greatly to increase the importance of the plant. Already the plant has been enlarged to a capacity of 15,000 tons of ore per day, and it is now able to produce about 70,000 tons of copper annually under normal operating conditions. From this basis further extensions are contemplated, although they will probably not be proceeded with until the world has settled down. On the programme as at present notified, the first stage will increase the output to about 85,000 tons of copper a year, the second stage to about 115,000 tons a year, and the third stage to about 160,000 tons a year.

The average price of cash standard copper: July 1920, £90. 5s. 6d.; June 1920, £88; May 1920, £96. 18s. 1d.; July 1919, £99. 14s. 5d.; June 1919, £83. 0s. 6d.; May 1919, £77. 16s. 7d.

TIN.—There has not been anything like the amount of activity and excitement in tin during July as was evidenced during some of the earlier months of this year, and the tone of the market has been much steadier, with indeed a pretty regular advance in prices. The aggressive bear attacks upon the market have altogether ceased, and the character of the trading almost suggests that before long there may be an upward movement, led by some of the interests most prominent recently in driving down prices. The statistical position is not so bad as might have been expected from the vigorous onslaughts made upon the market, and indeed there is a pronounced scarcity of Straits tin, which has been commanding a big premium. The East has been holding up prices at a very high figure, and has realized well over £290 a ton, while the market here was fully £20 lower. Efforts have been made by mining and other interests in the Federated Malay States to induce the Government to come to the assistance of the tin-mining industry out there, and the matter has been fully discussed, but apparently the authorities are not willing to use public funds for the purpose of perpetuating artificial conditions. At all events no success has attended the representations put forward by the mining community, and left to itself, prices have moved upward. For a time very little tin was sold, but during the latter half of the month a substantial business was concluded, which should have accordingly eased the

DAILY LONDON METAL PRICES: OFFICIAL CLOSING
Copper, Lead, Zinc, and Tin per Long

	COPPER				
	Standard Cash	Standard (3 mos.)	Electrolytic Ingots	Electrolytic Wire-Bars	Best Selected
July	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
12	91 5 0 to 91 10 0	93 15 0 to 94 0 0	105 0 0 to 110 0 0	108 0 0 to 110 0 0	103 0 0 to 105 0 0
13	90 15 0 to 91 0 0	93 0 0 to 93 5 0	105 0 0 to 110 0 0	108 0 0 to 110 0 0	103 0 0 to 105 0 0
14	90 0 0 to 90 5 0	92 10 0 to 92 15 0	105 0 0 to 110 0 0	108 0 0 to 110 0 0	103 0 0 to 105 0 0
15	90 5 0 to 90 10 0	92 5 0 to 92 10 0	106 0 0 to 111 0 0	109 0 0 to 111 0 0	103 0 0 to 105 0 0
16	90 0 0 to 90 5 0	92 10 0 to 92 12 6	106 0 0 to 111 0 0	109 0 0 to 111 0 0	104 0 0 to 106 0 0
19	90 5 0 to 90 10 0	92 15 0 to 93 0 0	106 0 0 to 111 0 0	109 0 0 to 111 0 0	104 0 0 to 106 0 0
20	91 5 0 to 91 10 0	93 5 0 to 94 0 0	109 0 0 to 112 0 0	111 0 0 to 112 0 0	107 0 0 to 108 0 0
21	90 15 0 to 91 0 0	93 5 0 to 93 10 0	109 0 0 to 112 0 0	111 0 0 to 112 0 0	107 0 0 to 108 0 0
22	91 0 0 to 91 5 0	93 5 0 to 93 10 0	107 0 0 to 112 0 0	110 0 0 to 112 0 0	107 0 0 to 108 0 0
23	91 5 0 to 91 10 0	93 15 0 to 94 0 0	107 0 0 to 113 0 0	111 0 0 to 113 0 0	106 0 0 to 108 0 0
26	92 0 0 to 92 5 0	94 5 0 to 94 10 0	108 0 0 to 114 0 0	112 0 0 to 114 0 0	106 0 0 to 108 0 0
27	92 0 0 to 92 5 0	94 5 0 to 94 7 6	108 0 0 to 114 0 0	112 0 0 to 114 0 0	105 0 0 to 107 0 0
28	91 0 0 to 91 5 0	93 10 0 to 93 12 6	108 0 0 to 114 0 0	112 0 0 to 114 0 0	105 0 0 to 107 0 0
29	90 15 0 to 91 0 0	93 5 0 to 93 7 6	110 0 0 to 115 0 0	113 0 0 to 115 0 0	105 0 0 to 107 0 0
30	92 5 0 to 92 10 0	94 10 0 to 94 15 0	110 0 0 to 116 0 0	113 0 0 to 116 0 0	107 0 0 to 109 0 0
August					
3	92 10 0 to 92 15 0	94 15 0 to 95 0 0	111 0 0 to 116 0 0	113 0 0 to 116 0 0	107 0 0 to 109 0 0
4	94 15 0 to 94 17 6	96 15 0 to 97 0 0	111 0 0 to 116 0 0	113 0 0 to 116 0 0	107 0 0 to 109 0 0
5	94 0 0 to 94 5 0	96 0 0 to 96 5 0	111 0 0 to 116 0 0	113 0 0 to 116 0 0	107 0 0 to 109 0 0
6	94 10 0 to 94 15 0	96 15 0 to 97 0 0	111 0 0 to 117 0 0	114 0 0 to 117 0 0	108 0 0 to 109 0 0
9	93 15 0 to 94 0 0	95 15 0 to 96 0 0	111 0 0 to 117 0 0	114 0 0 to 117 0 0	108 0 0 to 109 0 0
10	93 10 0 to 93 15 0	95 10 0 to 95 15 0	111 0 0 to 117 0 0	114 0 0 to 117 0 0	108 0 0 to 109 0 0

position of holders in the East. China, owing to the fall in silver, came out as a seller on a pretty substantial scale, and has probably marketed fully 4,000 tons of tin recently. This metal is now coming forward to Europe and America, and will help to increase the stocks. The supplies held now in producing countries have been substantially reduced, and to this extent the market stands on a sounder footing than for some time past.

The average price of cash tin: July 1920, £262. 1s. 5d.; June 1920, £250. 18s. 6d.; May 1920, £295. 3s. 7d.; July 1919, £253. 5s. 1d.; June 1919, £238. 8s. 1d.; May 1919, £234. 9s. 5d.

LEAD.—Some further liquidation of lead took the price of prompt deliveries down to nearly £33 early in the month, but later on there was a sharp upward movement, based upon purchases of prompt lead for shipment from this country to the United States. These purchases probably amount to about 4,000 tons so far. The reason appears to be that American corroders find it difficult to obtain supplies from inland points owing to the transport situation in the United States, and are purchasing metal here for conversion, in fulfilment of export orders for white lead. No doubt the low price of sterling favours transactions of this nature, and it is quite possible that further business of the same kind will result. It is, however, a topsy-turvey situation, and indicative of the general disjointedness of the times. A certain amount of speculative lead which was not forced out on the decline is still held here, and will have to come out sooner or later, but the holders appear to be strong interests, and no doubt can afford to look on for a time especially if the market continues to improve. Present prices, however, seem to be quite high enough, all circumstances being taken into consideration, and it will certainly be a hard matter to bring in any general speculative buying. Home consumption is undoubtedly at a low ebb, and apart from the electrical trade, which continues to take fair quantities, very little business indeed is being done. Straggling inquiries come in for export, in which Canada has made rather a respectable show, but elsewhere there is not much business about. Production in America is to all appearance affected adversely by the strikes, while as already stated consumers are being inconvenienced by inability to obtain supplies owing to the railway congestion. Reports from Australia suggest that after many weary months there is a prospect of the Broken Hill strike coming to an end. Probably the men will be only too glad to return, and would have done so long ago had it not been for the action of their leaders.

The average price of lead: July 1920, £35. 9s. 0d.; June 1920, £35. 1s. 4d; May 1920, £39. 3s. 2d.; July 1919, £23. 14s. 2d.; June 1919, £22. 12s. 2d; May 1919, £23. 18s. 6d.

SPELTER.—Prices have fluctuated within comparatively narrow limits during the past month, although early in July there was a sharp rise which carried prompt up to £44, the improvement, however, being short-lived, and by the middle of the month the price was down to below £41. The main factors at work in the market appear to be the steady development of offerings from the Continent, in which Germany and Norway have been predominating. Germany in fact has been putting forward offers of very big quantities both of virgin and re-melted spelter, and has been much more amenable in the matter of prices. On the other hand, America has not been offering at all, probably because our market has been far below parity, and because transport congestion has proved an obstacle. Good quantities of metal have been coming in, however, largely from the United States, and some decent quantities have gone direct to consumers, but new buying has been of a halting character, the galvanizers in particular being very well booked and in some cases endeavouring to postpone deliveries. Much disappointment is felt at the intractability of labour, the individual output all over the country being deplorably poor. This is restricting consumption, and is indeed one considerable cause of the slackness in demand. Continental sales have been facilitated by the rising exchange, and business with America has been rendered more difficult than ever because of the fall in sterling. It seems more and more likely that our market will be able to supply itself from sources nearer home than America. Following upon the closing of two of the South Wales works already referred to in last month's issue, it is understood that at least one more plant is stopping operations, but the output

PRICES ON THE LONDON METAL EXCHANGE.
Tons; Silver per Standard Ounce; Gold per Fine Ounce.

Lead		Zinc (Spelter)	Standard Tin		Silver		Gold	
Soft Foreign	English		Cash	3 mos.	Cash	Forward		
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.			s. d.	July
34 10 0 to 36 0 0	37 0 0	42 15 0 to 44 0 0	264 10 0 to 265 0 0	271 0 0 to 271 10 0	53⅛	52	104 3	12
34 15 0 to 36 10 0	37 10 0	42 10 0 to 43 15 0	266 0 0 to 266 10 0	271 10 0 to 272 0 0	53⅝	52⅜	104 6	13
34 10 0 to 36 0 0	37 0 0	41 15 0 to 43 0 0	265 15 0 to 266 0 0	271 10 0 to 272 0 0	53¾	52⅜	105 0	14
34 0 0 to 35 10 0	36 10 0	41 0 0 to 42 10 0	265 15 0 to 266 0 0	271 10 0 to 272 0 0	53⅝	52¼	106 6	15
33 10 0 to 35 0 0	36 0 0	40 15 0 to 42 5 0	267 15 0 to 268 0 0	272 15 0 to 273 0 0	52½	51¾	106 6	16
34 5 0 to 35 15 0	37 0 0	41 10 0 to 43 5 0	268 10 0 to 269 0 0	273 0 0 to 273 10 0	52	51½	107 0	19
34 5 0 to 35 10 0	37 0 0	41 15 0 to 43 10 0	268 0 0 to 268 10 0	273 0 0 to 272 10 0	52¾	51¾	107 9	20
34 15 0 to 36 0 0	37 10 0	41 0 0 to 42 15 0	262 10 0 to 263 0 0	267 10 0 to 268 0 0	55¼	54¼	107 3	21
35 5 0 to 36 0 0	37 10 0	41 10 0 to 43 5 0	263 10 0 to 264 0 0	268 0 0 to 269 0 0	55¼	54½	107 9	22
37 0 0 to 38 0 0	39 10 0	42 5 0 to 44 0 0	270 0 0 to 270 10 0	275 0 0 to 275 10 0	54⅜	54	108 3	23
37 5 0 to 37 7 6	39 10 0	42 0 0 to 44 0 0	270 5 0 to 270 10 0	275 15 0 to 276 0 0	56⅝	56⅛	108 9	26
36 15 0 to 36 15 0	39 0 0	41 15 0 to 43 10 0	267 0 0 to 267 10 0	271 0 0 to 271 10 0	55½	55¼	108 9	27
36 5 0 to 36 5 0	38 10 0	41 10 0 to 43 5 0	267 0 0 to 267 10 0	271 10 0 to 271 15 0	56⅛	55⅞	108 9	28
36 7 6 to 36 7 6	38 10 0	41 0 0 to 42 15 0	265 0 0 to 265 10 0	270 0 0 to 270 10 0	56⅛	56	109 9	29
37 5 0 to 37 10 0	39 10 0	41 5 0 to 42 15 0	268 5 0 to 268 10 0	273 5 0 to 273 10 0	56¼	56⅛	110 6	30
								August
37 15 0 to 38 0 0	40 0 0	41 10 0 to 43 0 0	273 0 0 to 273 10 0	278 0 0 to 278 10 0	57	57	112 0	3
38 12 6 to 38 15 0	40 10 0	42 15 0 to 44 10 0	275 5 0 to 275 10 0	279 15 0 to 280 0 0	57⅛	57⅜	114 6	4
37 10 0 to 37 15 0	40 0 0	42 10 0 to 44 0 0	283 10 0 to 284 0 0	289 0 0 to 289 10 0	58¼	58½	114 0	5
37 5 0 to 37 5 0	40 0 0	42 5 0 to 43 15 0	283 10 0 to 284 0 0	288 0 0 to 288 10 0	59⅜	59⅝	114 3	6
36 15 0 to 36 15 0	40 0 0	42 10 0 to 43 15 0	279 10 0 to 280 0 0	285 10 0 to 286 0 0	59⅝	59⅞	113 3	9
36 10 0 to 36 15 0	40 0 0	42 5 0 to 43 15 0	279 10 0 to 280 0 0	286 10 0 to 286 15 0	59⅜	59⅝	113 8	10

of English spelter is no factor in the market under present conditions, and the reduced home output passes unnoticed.

The average price of spelter: July 1920, £42. 13s. 6d.; June 1920, £42. 2s. 11d.; May 1920, £46. 0s. 9d.; July 1919, £42. 3s. 10d.; June 1919, £36. 19s. 6d.; May 1919, £35. 13s. 9d.

ZINC DUST.—High-grade Australian zinc dust remains unchanged at about £85 per ton.

ANTIMONY.—There has been no alteration in the nominal price of English regulus, which ranges from £60 to £63 per ton according to grade, but foreign regulus, after keeping steady for a time, has become distinctly easier, and warehouse material could probably be done at £45, although odd lots have changed hands at a higher figure.

ARSENIC.—There is not much demand, but prices are firm at about £76 to £78 for white delivered London.

BISMUTH.—A day-to-day business continues at about 12s. 6d. per lb.

CADMIUM.—There has been a moderate demand, and orders are being filled at about 6s. 3d. to 6s. 6d. per lb.

ALUMINIUM.—The position remains without alteration, with £165 ruling for the home trade, and £185 asked for export.

NICKEL.—There is no alteration in this market, which remains featureless, with £230 quoted alike for home trade and export.

COBALT METAL.—There is a steady inquiry at about 14s. per lb.

COBALT OXIDE.—The price remains as before at about 10s. per lb. for black.

PLATINUM.—There is very little business doing in this country, but the price is now nominally about £21 per oz.

PALLADIUM.—The market remains more or less nominal at about £20.

QUICKSILVER.—The tone has been somewhat irregular, although first hands have maintained a firm front, and continue to quote £21. Second-hand parcels, however, are to be had in the neighbourhood of £20. 10s.

SELENIUM.—10s. 6d. to 13s. per lb.

TELLURIUM.—Nominally 90s. to 95s. per lb.

SULPHATE OF COPPER.—The demand remains quiet with prices ranging from about £44 upwards according to delivery.

MANGANESE ORES.—There is a fair demand, but consumers appear to be getting as much material as they want without affecting prices. A few cargoes of Indian grades have come in and some shipments of Caucasian ore have also arrived. Prices all round range from 4s. to 4s. 3d. c.i.f.

TUNGSTEN ORES.—There has not been very much demand from the home trade, but a little business is reported for the Continent. Home trade prices are about 26s. 6d. to 27s. 6d. per unit for 65%, while sales have been made to Germany at 28s. c.i.f. Hamburg.

MOLYBDENITE.—The market is very quiet, and the quotation is more or less nominal at about 70s. per unit.

SILVER.—Prices, after keeping steady during the greater part of the month, show irregularity toward the close, with an upward tendency owing to some buying orders for India having to be executed. The month opened at 52d., the price then falling to 51½d., and advancing to 56⅝d. on July 26, this also being the quotation at the end of that month.

GRAPHITE.—There is a regular inquiry, without change in the general situation. Soft velvety flake is about £60 to £80 for 85% to 90%, while Madagascar 82% to 85% is somewhere about £25 c.i.f.

CHROME ORES.—The market seems to be easier with about £8 to £9 quoted for 48% to 50%.

IRON AND STEEL.—There has been little alteration in the iron and steel markets during the last month. As regards pig iron, the scarcity of Cleveland foundry iron has continued unrelieved, so that the demand from home consumers has far exceeded the supply. Makers, in consequence, have had to continue their policy of declining export business. Prices are unchanged, but in view of the anticipated advance in railway rates and other transport charges, producers are covering themselves by inserting clauses in all contracts. With respect to finished and semi-finished material there has been a decided falling off in the demand, especially from overseas, and there seems no doubt that prices are on the wane. But as yet makers have made no alteration, being so heavily booked.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Par Value
	Oz.	Oz.	Oz.	£
April, 1919	676,702	18,242	694,944	2,951,936
May	706,158	18,837	724,995	3,079,583
June	682,603	19,776	702,379	2,983,515
July	705,523	19,974	725,497	3,081,713
August	686,717	19,952	706,669	3,001,739
September	680,359	18,199	698,558	2,967,287
October	705,313	18,409	723,722	3,074,174
November	657,845	20,125	677,920	2,879,834
December	631,833	18,358	650,191	2,761,836
Year 1919	8,111,271	218,820	8,330,091	35,383,974
January 1920	653,295	17,208	670,503	*
February	607,918	17,412	625,330	*
March	689,645	17,391	707,036	*
April	667,926	19,053	686,979	*
May	681,551	17,490	699,041	*
June	699,199	16,758	715,957	*

* Not given in the official returns.

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
May 31, 1919	173,376	12,232	5,939	191,547
June 30	172,505	12,544	5,831	190,880
July 31	173,613	12,453	5,736	191,802
August 31	170,844	12,450	5,655	188,949
September 30	169,120	12,392	5,294	186,806
October 31	167,499	12,691	4,492	184,682
November 30	164,671	12,565	4,337	181,573
December 31	166,155	12,750	4,271	183,176
January 31, 1920	176,390	12,766	4,796	193,952
February 29	185,185	12,708	5,217	203,110
March 31	188,564	12,788	5,232	206,584
April 30	189,446	12,951	5,057	207,454
May 31	184,722	12,897	4,793	202,412
June 30	179,827	13,036	4,596	197,459

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 65% of the working profit. Figures for yield and profit for 1919 based on par value of gold; subsequently gold premium included.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
May, 1919	2,099,450	28 4	22 3	5 10	608,715
June	2,032,169	28 4	22 4	5 10	592,361
July	2,134,668	27 10	21 9	6 0	611,118
August	2,036,128	28 5	22 11	5 5	551,203
September	2,019,109	28 6	22 10	5 7	560,979
October	2,108,698	28 3	22 6	5 10	612,841
November	1,933,526	28 8	23 5	5 5	521,472
December	1,845,088	28 8	25 6	3 10	354,098
Year 1919	24,043,638	28 7	22 11	5 6	6,605,509
January, 1920	2,038,092	34 4	24 2	10 2	1,036,859
February	1,869,180	35 1	28 3*	6 10*	644,571*
March	2,188,104	31 8	25 2	6 6	716,610
April	2,065,446	31 5	26 3	5 2	533,940
May	2,117,725	31 9	25 11	5 10	618,147

* Results affected by the back-pay disbursed in accordance with new wages agreement.

Production of Gold in Rhodesia and West Africa.

	Rhodesia, 1919	Rhodesia, 1920	West Africa, 1919	West Africa, 1920
	£	oz.	£	
January	211,917	43,428	104,063	No official returns published.
February	220,885	44,237	112,616	
March	225,808	45,779	112,543	
April	213,160	[illegible]	109,570	
May	218,057	46,266	100,827	
June	214,215	45,054	106,612	
July	214,919	—	102,467	
August	207,339	—	103,112	
September	223,719	—	100,401	
October	204,184	—	91,352	
November	186,462	—	[illegible]	
December	158,835	—	[illegible]	
Total	2,499,498	271,764	1,240,691	

Transvaal Gold Outputs.

	May Treated	May Yield	June Treated	June Yield
	Tons	Oz.	Tons	Oz.
Aurora West	10,240	£13,081	10,400	£13,942
Brakpan	47,200	£82,887	49,500	19,687
City & Suburban	—	—	—	— *
City Deep	78,400	30,006	86,000	33,867
Cons. Langlaagte	44,800	£66,848	45,000	£66,628
Cons. Main Reef	50,100	17,875	51,100	18,754
Crown Mines	189,000	58,188	190,000	58,570
Durban Roodepoort Deep	21,700	6,928	24,100	7,372
East Rand P.M.	124,000	34,703	128,000	35,690
Ferreira Deep	32,000	10,767	33,300	10,257
Geduld	43,500	15,417	43,000	15,222
Geldenhuis Deep	44,200	13,042	47,600	13,521
Glynn's Lydenburg	3,680	£6,931	3,482	£5,537
Goch	16,500	£16,492	16,000	£16,489
Government G.M. Areas	122,500	£257,384	130,000	£259,338
Heriot	—	—	—	—
Jupiter	23,100	5,648	—	—
Kleinfontein	45,560	13,341	44,040	13,221
Knight Central	25,100	7,576	26,200	7,899
Knights Deep	96,100	17,904	90,000	16,746
Langlaagte Estate	42,000	£65,331	41,350	£70,050
Luipaard's Vlei	19,585	£26,719	19,000	£25,566
Meyer & Charlton	14,200	£44,410	14,050	£47,137
Modderfontein	86,000	44,121	84,000	43,535
Modderfontein B	50,200	24,235	51,500	26,101
Modderfontein Deep	40,800	21,689	42,400	22,147
Modderfontein East	18,500	£11,835	21,000	£3,300†
New Unified	10,300	£14,770	11,100	£14,722
Nourse	42,500	14,006	42,800	14,060
Primrose	20,000	£21,592	20,500	£21,054
Princess Estate	19,000	4,640	—	2,580
Randfontein Central	148,000	£176,696	151,000	£196,556
Robinson	40,300	9,461	40,000	9,562
Robinson Deep	52,500	16,662	57,100	18,687
Roodepoort United	24,000	£25,293	24,000	£24,666
Rose Deep	55,800	14,719	58,700	15,540
Simmer & Jack	56,800	14,613	60,100	14,174
Simmer Deep	50,500	11,304	—	—
Springs	38,000	75,952	34,700	16,464
Sub Nigel	10,300	6,285	10,700	6,432
Transvaal G.M. Estates	16,650	£29,703	14,590	£26,253
Van Ryn	37,750	£42 271	36,800	£42,132
Van Ryn Deep	46,500	£132,492	50,200	£127,114
Village Deep	47,900	15,369	44,800	15,324
Village Main Reef	15,700	5,086	16,300	5,162
West Rand Consolidated	33,450	£45,713	31,800	£43,356
Witwatersrand (Knights)	37,500	£54,939	35,200	£50,904
Witwatersrand Deep	32,000	7,547	30,850	7,867
Wolhuter	32,500	8,624	32,000	8,621

* Mine now being worked by City Deep. † Profit.

West African Gold Outputs.

	May Treated	May Value	June Treated	June Value
	Tons	Oz.	Tons	Oz.
Abbontiakoon	8,543	£15,146	7,898	£14,680
Abosso	6,120	2,449	6,060	2,337
Akoko	—	—	—	—
Ashanti Goldfields	5,900	6,337	6,424	7,288
Obbuassi	660	854	—	—
Prestea Block A	9,214	£13,942	7,638	£16,372
Taquah	4,050	2,495	—	£7,449

Rhodesian Gold Outputs.

	May Treated	May Value	June Treated	June Value
	Tons	£	Tons	£
Falcon	12,230	20,410*	15,390	28,451*
Gaika	3,357	5,368	3,375	5,881
Globe & Phœnix	5,565	8,790†	6,207	7,916†
London & Rhodesian	2,415	2,832	—	—
Lonely Reef	4,650	5,209†	4,820	5,348†
Rezende	5,500	2,535†	5,500	2,474†
Rhodesia, Ltd.	605	240	735	286
Rhodesia, G.M. & I.	604	430	607	352
Shamva	55,150	41,770	50,550	40,695
Transvaal & Rhodesian	1,600	4,575	—	—

* Gold, Silver and Copper; † Ounces Gold.

West Australian Gold Statistics.—Par Values.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
May, 1919	525	68,655	69,180	293,856
June	1,050	73,546	74,596	316,862
July	680	68,028	68,708	292,852
August	835	58,117	58,952	250,410
September	†	†	†	†
October	586	64,987	65,573	278,535
November	1,171	64,823	65,994	280,323
December	831	27,334	28,165	162,575
January, 1920	836	25,670	26,506	112,590
February	1,928	49,453	51,381	218,251
March	*nil*	54,020	54,020	229,461
April	835	56,256	57,091	242,506
May	227	50,976	51,203	217,495
June	502	56,679	57,181	242,638
July	—	48,341	48,341	205,340

† Figures not received.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1919	1920	1919	1920	1919	1920
	£	Oz.	£	Oz.	£	£
January	36,238	7,105	37,100	4,724	18,000	28,000
February	46,955	8,677	43,330	7,200	24,000	15,000
March	40,267	24,126	48,000	6,973	16,000	22,000
April	63,818	6,368	61,200	8,368	24,000	12,000
May	37,456	—	38,200	8,400	16,000	13,800
June	41,465	—	44,600	13,700	17,000	8,700
July	37,395	—	42,060	—	22,000	17,410
August	51,564	—	49,700	—	20,000	—
September	76,340	—	37,120	—	13,000	—
October	39,018	—	36,100	—	28,000	—
November	40,735	—	32,720	—	51,000	—
December	63,311	—	44,500	—	31,000	—
Total	575,260	46,276	514,630	49,365	280,000	116,910

Australasian Gold Outputs.

	May.		June.	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Associated	5,819	6,003	5,605	7,698
Blackwater	2,180	3,716	2,128	3,967
Bullfinch	4,730	5,200	6,250	1,871‡
Golden Horseshoe	11,832	5,360‡	11,664	4,894‡
Great Boulder Prop.	7,680	23,026	8,243	23,855
Ivanhoe	14,148	4,467‡	14,004	4,269‡
Kalgurli	4,969	8,641	4,515	7,723
Lake View & Star	10,035	10,945	10,148	11,804
Menzies Consolidated	1,670	3,189	1,540	3,065
Oroya Links	1,727	10,045†	1,320	8,428
Progress	1,130	1,228	1,250	1,161
Sons of Gwalia	12,478	16,423	10,864	15,067
South Kalgurli	7,590	3,721‡	8,040	3,213‡
Waihi	12,681	4,025‡	12,948	4,278‡
Waihi Grand Junction	—	—	5,890	1,881‡

† Total receipts; ‡ Oz.; A Six weeks.

Miscellaneous Gold Outputs.—Par Values.

	May.		June.	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
El Oro (Mexico)	30,750	224,000†	30,500	224,000†
Esperanza (Mexico)	22,862	145‡	24,876	3,550§
Frontino & Bolivia (C'lbia)	2,500	9,433	2,710	11,090
Mexico El Oro (Mexico)	11,300	173,690†	11,850	196,290†
Oriental Cons. (Korea)	—	95,500†	—	80,000†
Ouro Preto (Brazil)	8,100	2,569‖	7,400	2,599‖
Plymouth Cons. (Calif'rnia)	7,200	10,099	6,650	9,606
St. John del Rey (Brazil)	—	37,000	—	35,000
Santa Gertrudis (Mexico)	26,745	20,192‡	28,010	20,390‡

§ Loss. † Dollars. ‡ Profit, gold and silver. ‖ Oz.

Production of Gold in India.

	1916	1917	1918	1919	1920
	oz.	oz.	oz.	oz.	oz.
January	45,214	44,718	41,420	38,184	39,073
February	43,121	42,566	40,787	36,834	38,872
March	43,702	44,617	41,719	38,317	38,760
April	44,797	43,726	41,504	38,248	37,307
May	45,055	42,901	40,889	38,608	38,191
June	44,842	42,924	41,264	38,359	37,864
July	45,146	42,273	40,229	38,549	37,129
August	45,361	42,591	40,496	37,850	—
September	45,255	43,207	40,088	36,813	—
October	45,061	43,041	39,472	37,138	—
November	45,247	42,915	36,984	39,628	—
December	48,276	44,883	40,149	42,643	—
Total	541,077	520,362	485,236	461,171	267,196

Indian Gold Outputs.

	June.		July.	
	Tons Treated	Fine Ounces	Tons Treated	Fine Ounces
Balaghat	3,100	2,301	3,150	2,363
Champion Reef	12,088	6,799	12,514	6,010
Mysore	20,143	13,945	20,432	13,133
North Anantapur	700	966	800	966
Nundydroog	8,242	6,220	8,646	6,235
Ooregum	12,700	7,633	12,800	8,422

Base Metal Outputs.

		May.	June.
Arizona Copper	Short tons copper	1,500	1,500
British Broken Hill	Tons lead conc.	—	—
	Tons zinc conc.	—	—
	Tons carbonate ore	—	—
Broken Hill Block 10	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Burma Corp.	Tons refined lead	1,510	2,113
	Oz. refined silver	189,900	265,620
Fremantle Trading	Long tons lead	—	—
Hampden Cloncurry	Tons copper	189	572
North Broken Hill	Tons lead	—	—
	Oz. silver	—	—
Poderosa	Tons copper ore	480	—
Rhodesian Broken Hill	Tons lead	1,250	1,210
Tanganyika	Long tons copper	1,725	1,961
Tolima	Tons silver-lead conc.	57	45
Zinc Corp.	Tons zinc conc.	—	—
	Tons lead conc.	—	—

Imports of Ores, Metals, etc., into United Kingdom.

		May.	June
Iron Ore	Tons	710,592	675,179
Manganese Ore	Tons	30,899	38,685
Copper and Iron Pyrites	Tons	68,112	45,032
Copper Ore, Matte, and Precipitate	Tons	2,185	1,761
Copper Metal	Tons	8,152	10,045
Tin Concentrate	Tons	3,485	3,013
Tin Metal	Tons	4,763	3,923
Lead, Pig and Sheet	Tons	14,568	9,343
Zinc (Spelter)	Tons	11,905	8,162
Quicksilver	Lb.	374,677	110,607
Zinc Oxide	Tons	280	180
White Lead	Cwt.	26,975	19,481
Barytes	Cwt.	86,449	41,763
Phosphate	Tons	69 209	57,150
Sulphur	Tons	6,105	385
Borax	Cwt.	—	1,975
Other Boron Compounds	Tons	2,598	1,894
Nitrate of Soda	Cwt.	101,785	478,608
Nitrate of Potash	Cwt.	15,524	26,867
Petroleum:			
Crude	Gallons	43,945	—
Lamp Oils	Gallons	13,369,666	10,186 219
Motor Spirit	Gallons	16,127,343	22,888,841
Lubricating Oils	Gallons	10,214,742	7,854,469
Gas Oil	Gallons	4,530,795	6,535,821
Fuel Oil	Gallons	24,626,289	32,070,055
Total Petroleum	Gallons	68,941,603	79,536,910

Outputs of Tin Mining Companies.
In Tons of Concentrate.

	April Tons	May Tons	June Tons
Nigeria:			
Associated Nigerian	20	20	20
Benue	4	–	–
Bisichi	12	5	6
Bongwelli	–	–	–
Dua	1¾	2	1½
Ex-Lands	20	25	30
Filani	5¼	3	5
Forum River	9	8	7
Gold Coast Consolidated	2½	2¼	3¾
Gurum River	14	13	14
Jantar	15	8	6
Jos	12½	8½	9¼
Kaduna	14½	8½	6¼
Kaduna Prospectors	9	5	6¾
Kano	9½	4	5¼
Kuru	12	9	10
Kwall	5	7	6
Lower Bisichi	5¾	5¾	6
Lucky Chance	1¾	1½	1
Minna	3¾	1¾	2½
Mongu	50	35	34
Naraguta	25	25	35
Naraguta Extended	14	14	20
Nigerian Consolidated	10	8½	9
Ninghi	7	6	4½
N.N. Bauchi	40	40	38
Offin River	27¾	20¼	–
Rayfield	50	40	35
Ropp	49	36	72
Rukuba	–	4	2
South Bukeru	10	6	6
Sybu	1¾	2	2½
Tin Fields	6	4	10
Federated Malay States:			
Chenderiang	–	–	78½*
Gopeng	65½	60	60
Idris Hydraulic	20¾	26¾	22½
Ipoh	14	14	11
Kamunting	–	–	88*
Kinta	35¾	41¾	41¾
Lahat	35¾	35¾	41⅔
Malayan Tin	65½	44½	65½
Pahang	215½	215	215½
Rambutan	18	15	18
Sungei Besi	29	30	31
Tekka	39	31	30
Tekka-Taiping	36	36	36
Tronoh	21	37	27
Cornwall:			
East Pool	63	72½	80
Geevor	33	36	36
Grenville	29½	34¾	35¾
South Crofty	47¼	54	52½
Other Countries:			
Aramayo Francke (Bolivia)	191	160	140
Berenguela (Bolivia)	31	32	28
Briseis (Tasmania)	24	25	20
Deebook (Siam)	26½	22	14
Mawchi (Burma)	100	105	82
Porco (Bolivia)	22	14	19
Renong (Siam)	[illegible]	40½	28½
Rooiberg Minerals (Transvaal)	55	24	50½
Siamese Tin (Siam)	[illegible]	87½	71½
Tongkah Harbour (Siam)	[illegible]	88	94
Zaaiplaats (Transvaal)	[illegible]	25	28

† Two months. * Three months.

Nigerian Tin Production.
In long tons of concentrate of unspecified content.
Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1915	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons	Tons
January	417	531	667	678	613	547
February	358	528	646	668	623	477
March	418	547	655	707	606	505
April	444	486	555	584	546	467
May	357	536	509	525	483	378
June	373	510	473	492	484	415
July	455	506	479	545	481	—
August	438	498	551	571	616	—
September	442	535	538	520	561	—
October	511	584	578	491	625	—
November	467	679	621	472	536	—
December	533	654	655	518	511	—
Total	5,213	6,594	6,927	6,771	6,685	2,789

Production of Tin in Federated Malay States.
Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons
January	4,316	3,558	3,149	3,765	4,265
February	3,372	2,755	3,191	2,673	3,014
March	3,696	3,286	2,608	2,819	2,770
April	3,177	3,251	3,308	2,855	2,606
May	3,729	3,413	3,332	3,404	2,741
June	3,435	3,489	2,950	2,873	2,940
July	3,517	3,253	3,373	3,756	2,824
August	3,732	3,413	3,259	2,955	—
September	3,636	3,154	3,166	3,161	—
October	3,681	3,436	2,870	3,221	—
November	3,635	3,300	3,131	2,972	—
December	3,945	3,525	3,023	2,413	—
	43,871	39,833	37,370	36,867	21,160

Total Sales of Tin Concentrate at Redruth Ticketings

	Long tons	Value	Average
August 11, 1919	127½	£17,125	£134 6 5
August 25	130½	£18,297	£140 4 3
September 8	115½	£16,588	£143 12 6
September 22	135½	£19,557	£144 6 9
October 8	72	£10,867	£150 18 7
October 20	32	£5,093	£159 3 2
November 3	34½	£5,235	£151 15 0
November 17	39	£6,161	£157 19 9
December 1	38	£5,905	£155 8 3
December 15	29	£5,133	£176 10. 0
December 31	14¾	£2,884	£195 10 10
Total and Average, 1919	2,858	£366,569	£128 5 0
January 12, 1920	31	£6,243	£201 8 0
January 26	51¾	£10,574	£204 6 10
February 9	37½	£7,880	£210 2 8
February 23	53¾	£12,120	£225 10 0
March 8	18	£4,038	£224 7 7
March 22	44	£8,286	£188 6 8
April 6	44½	£8,367	£188 0 5
April 19	33½	£6,375	£190 6 0
May 3	61½	£11,641	£1 9 5 9
May 17	44	£6,151	£139 16 0
May 31	10	£1,578	£157 16 0
June 14	24¾	£3,278	£132 9 3
June 28	14½	£1,932	£133 4 10
July 12	43¾	£6,133	£140 4 0
July 26	10½	£1,643	£156 10 0

Details of Redruth Tin Ticketings.

	July 12		July 26	
	Tons	Realized	Tons	Realized
		£ s. d.		£ s. d.
Tincroft Mines	11	151 5 0	10½	156 10 0
Penryn Minerals	10	137 2 6	—	—
"	3½	136 0 0	—	—
"	2¾	134 0 0	—	—
"	5	137 15 0	—	—
"	6½	135 15 0	—	—
"	5	136 0 0	—	—
Total	[illegible]	—	10½	156 10 0

Stocks of Tin

Reported by A. Strauss & Co. Long Tons.

	June 30.	July 31.
	Tons	Tons
Straits and Australian Spot	347	853
Ditto, Landing and in Transit	730	155
Other Standard, Spot and Landing	4,882	3,525
Straits, Afloat	900	1,250
Australian, Afloat	207	169
Banca, in Holland	413	1,160
Ditto, Afloat	800	1,323
Billiton, Spot	—	—
Billiton, Afloat	—	145
Straits, Spot in Holland and Hamburg	—	—
Ditto, Afloat to Continent	301	60
Total Afloat for United States	6,717	7,916
Stock in America	3,586	1,926
Total	18,883	18,482

Shipments, Imports, Supply, and Consumption of Tin.

Reported by A. Strauss & Co. Long tons.

	June	July
	Tons	Tons
Shipments from:		
Straits to U.K.	750	1,275
Straits to America	3,210	2,555
Straits to Continent	301	35
Straits to Other Places	289	152
Australia to U.K.	150	250
U.K. to America	1,217	1,244
Imports of Bolivian Tin into Europe	1,993	—
Supply:		
Straits	4,261	3,865
Australian	150	250
Billiton	—	145
Banca	914	1,470
Standard	1,498	1,614
Total	6,823	7,344
Consumption:		
U.K. Deliveries	1,691	1,939
Dutch "	—	—
American "	6,500	5,530
Straits, Banca & Billiton, Continental Ports, etc.	550	276
Total	8,741	7,745

Dividends Declared by Mining Companies.

Date	Company	Par Value of Shares	Amount of Dividend
July 22	Bechuanaland Exploration	10s.	8% less tax
Aug. 3	Bisichi Tin	£1.	2s.
July 27	Broken Hill Proprietary	£1.	9d.
July 23	Eastern Smelting	Prf. Ord. £1.	2s.
July 22	Glynn's Lydenburg	£1.	6d.
July 10	Great Boulder Perseverance	£1.	6d.*
Aug. 9	Hollinger Consolidated	$5	5 cents less tax
July 15	New African	£1.	2s. less tax
July 15	Oriental Consolidat'd	$10.	50 cents
Aug. 10	Rambutan	£1.	8d. less tax
July 19	Rhodesia Broken Hill	10s.	6d. less tax
July 19	Rhodesia Copper	3s.	12½% less tax
July 14	South Kalgurli	10s.	9d. less tax
Aug. 6	Tekka	£1.	4½d. less tax
July 9	Tin Fields of Northern Nigeria	£1.	1s. 6d. less tax
July 23	Waihi	£1.	1s. tax free
July 29	Wankie Colliery	10s.	6d. less tax

* Third liquidation dividend.

PRICES OF CHEMICALS. August 10.

These quotations are not absolute; they vary according to quantities required and contracts running.

		£	s.	d.
Alum	per ton	20	0	0
Alumina, Sulphate of	"	16	10	0
Ammonia, Anhydrous	per lb.		2	6
" 0·880 solution	per ton	38	10	0
" Carbonate	per lb.			7½
" Chloride of, grey	per ton	60	0	0
" " " pure	per cwt.	5	5	0
" Nitrate of	per ton	70	0	0
" Phosphate of	"	120	0	0
" Sulphate of	"	23	10	0
Antimony Sulphide, Golden	per lb.		1	6
Arsenic, White	per ton	72	0	0
Barium Sulphate	"	12	0	0
Bisulphate of Carbon	"	60	0	0
Bleaching Powder, 35% Cl.	"	26	0	0
Borax	"	41	0	0
Copper, Sulphate of	"	42	0	0
Cyanide of Sodium, 100%	per lb.		1	0
Hydrofluoric Acid	"			7½
Iodine	"		16	0
Iron, Sulphate of	per ton	4	0	0
Lead, Acetate of, white	"	85	0	0
" Nitrate of	"	66	0	0
" Oxide of, Litharge	"	58	0	0
" White	"	65	0	0
Lime, Acetate, brown	"	20	0	0
" " grey 80%	"	33	0	0
Magnesite, Calcined	"	25	0	0
Magnesium, Chloride	"	17	0	0
" Sulphate	"	13	0	0
Methylated Spirit 64° Industrial	per gal.		8	0
Phosphoric Acid	per lb.		1	9
Potassium Bichromate	per lb.		2	1
" Carbonate 85%	per ton	110	0	0
" Chlorate	per lb.		0	9
" Chloride 80%	per ton	40	0	0
" Hydrate (Caustic) 90%	"	120	0	0
" Nitrate	"	66	0	0
" Permanganate	per lb.		4	6
" Prussiate, Yellow	"		2	1
" Sulphate, 90%	per ton	45	0	0
Sodium Metal	per lb.		1	3
" Acetate	per ton	55	0	0
" Arsenate 45%	"	60	0	0
" Bicarbonate	"	8	10	0
" Bichromate	per lb.		1	9
" Carbonate (Soda Ash)	per ton	15	0	0
" " (Crystals)	"	5	10	0
" Chlorate	per lb.			5½
" Hydrate, 76%	per ton	32	0	0
" Hyposulphite	"	34	0	0
" Nitrate, 95%	"	24	0	0
" Phosphate	"	44	0	0
" Prussiate	per lb.		1	4
" Silicate	per ton	11	0	0
" Sulphate (Salt-cake)	"	6	0	0
" " (Glauber's Salts)	"	10	0	0
" Sulphide	"	62	0	0
Sulphur, Roll	"	19	0	0
" Flowers	"	19	0	0
Sulphuric Acid, Non-Arsenical, 140°T.	"	5	0	0
" " " 90%	"	7	5	3
" " " 96%	"	9	7	6
Superphosphate of Lime, 18%	"	5	0	0
Tartaric Acid	per lb.		3	0
Zinc Chloride	per ton	27	0	0
Zinc Sulphate	"	22	10	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	August 8 1919 £ s. d.	August 6 1920 £ s. d.
RAND:		
Brakpan	3 10 0	2 16 3
Central Mining (£8)	9 8 9	8 13 9
City & Suburban (£4)	13 0	6 6
City Deep	3 0 0	2 13 9
Consolidated Gold Fields	1 18 9	1 10 0
Consolidated Langlaagte	1 0 6	17 6
Consolidated Main Reef	14 9	14 6
Consolidated Mines Selection (10s.)	1 5 0	1 2 6
Crown Mines (10s.)	2 8 9	2 13 9
Daggafontein	1 5 0	13 0
Durban Roodepoort Deep	8 9	4 0
East Rand Proprietary	7 0	8 0
Ferreira Deep	13 0	8 3
Geduld	2 10 0	2 0 0
Geldenhuis Deep	11 3	6 6
Gov't Gold Mining Areas	4 17 6	4 7 6
Heriot	13 9	6 3
Johannesburg Consolidated	1 8 9	1 9 3
Jupiter	5 0	2 3
Kleinfontein	12 9	7 6
Knight Central	6 9	4 3
Knights Deep	9 0	7 3
Langlaagte Estate	1 1 6	15 0
Meyer & Charlton	4 18 9	4 17 6
Modderfontein (10s.)	27 10 0*	3 13 9
Modderfontein B	9 2 6	6 15 0
Modder Deep (5s.)	8 5 0†	2 6 3
Modder East	—	1 3 9
New State Areas	—	1 6 3
Nourse	15 0	10 6
Rand Mines (5s.)	3 3 9	2 18 9
Rand Selection Corporation	3 13 9	2 15 0
Randfontein Central	13 6	13 0
Robinson (£5)	14 0	9 0
Robinson Deep A (1s.)	18 9	1 1 3
Rose Deep	18 9	16 3
Simmer & Jack	5 3	3 9
Simmer Deep	3 0	9
Springs	2 17 6	2 1 3
Sub-Nigel	1 6 3	16 3
Union Corporation (12s. 6d.)	17 3	17 9
Van Ryn	18 9	17 0
Van Ryn Deep	3 18 9	4 5 0
Village Deep	15 9	10 9
Village Main Reef	13 0	5 3
West Springs	—	18 9
Witwatersrand (Knight's)	1 5 0	13 9
Witwatersrand Deep	13 0	9 0
Wolhuter	4 9	4 0
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	1 0 0	11 3
Transvaal Gold Mining Estates	13 6	10 0
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	24 12 6	20 0 0
Jagersfontein	6 7 6	4 2 6
Premier Deferred (2s. 6d.)	9 5 0	10 10 0
RHODESIA:		
Cam & Motor	5 6	11 3
Chartered British South Africa	1 2 0	16 3
Falcon	14 0	9 0
Gaika	16 0	16 0
Globe & Phœnix (5s.)	1 4 6	15 3
Lonely Reef	2 12 6	3 0 0
Rezende	5 7 6	2 17 6
Shamva	1 17 6	1 17 6
Willoughby's (10s.)	6 3	5 9
WEST AFRICA:		
Abbontiakoon (10s.)	4 9	3 0
Abosso	10 6	10 6
Ashanti (4s.)	1 2 6	17 6
Prestea Block A	5 9	3 0
Taquah	16 6	15 0
WEST AUSTRALIA:		
Associated Gold Mines	4 0	2 6
Associated Northern Blocks	3 9	3 0
Bullfinch	2 6	3 6
Golden Horse-Shoe (£5)	1 7 6	16 3
Great Boulder Proprietary (2s.)	[illegible] 9	7 9
Great Fingall (10s).	1 9	1 9
Hampton Properties	—	10 0
Ivanhoe (£5)	1 17 6	1 0 0
Kalgurli	10 0	13 9
Lake View Investment (10s.)	1 0 0	17 0
Sons of Gwalia	5 [illegible]	5 6
South Kalgurli (10s.)	5 3	6 6
GOLD, SILVER, cont.		
OTHERS IN AUSTRALASIA:		
Blackwater, New Zealand	8 9	8 9
Consolidated G.F. of New Zealand	3 9	3 9
Mount Boppy, N.S.W. (10s.)	0 9	5 0
Progress, New Zealand	1 9	1 9
Talisman, New Zealand	8 9	6 6
Waihi, New Zealand	2 6 3	1 15 0
Waihi Grand Junction, New Z'lnd	14 0	10 0
AMERICA:		
Buena Tierra, Mexico	18 0	10 0
Camp Bird, Colorado	1 7 0	12 0
El Oro, Mexico	1 2 9	12 6
Esperanza, Mexico	16 9	10 6
Frontino & Bolivia, Colombia	9 3	11 3
Le Roi No. 2 (£5), British Columbia	11 3	10 0
Mexico Mines of El Oro, Mexico	7 2 6	5 10 0
Nechi (Pref. 10s.), Colombia	12 3	8 9
Oroville Dredging, Colombia	1 12 6	1 3 3
Plymouth Consolidated, California	1 9 3	13 9
St. John del Rey, Brazil	18 0	16 0
Santa Gertrudis, Mexico	1 14 6	1 3 0
Tomboy, Colorado	15 6	7 6
RUSSIA:		
Lena Goldfields	1 10 0	1 0 0
Orsk Priority	—	10 0
INDIA:		
Balaghat (10s.)	6 0	8 6
Champion Reef (2s. 6d.)	4 3	2 9
Mysore (10s.)	2 2 6	13 3
North Anantapur	3 6	4 0
Nundydroog (10s.)	17 6	10 9
Ooregum (10s.)	16 0	13 9
COPPER:		
Arizona Copper (5s.), Arizona	2 0 0	2 6 3
Cape Copper (£2), Cape and India	2 15 0	1 5 0
Esperanza, Spain	5 9	5 0
Hampden Cloncurry, Queensland	1 0 6	12 6
Mason & Barry, Portugal	2 3 9	1 10 0
Messina (5s.), Transvaal	5 0	5 6
Mount Elliott (£5), Queensland	3 15 0	1 5 0
Mount Lyell, Tasmania	1 4 0	1 3 3
Mount Morgan, Queensland	1 5 0	18 3
Mount Oxide, Queensland	8 6	3 9
Namaqua (£2), Cape Province	1 15 0	1 12 6
Rio Tinto (£5), Spain	58 0 0	37 0 0
Russo-Asiatic Consd., Russia	—	10 3
Sissert, Russia	1 2 6	11 3
Spassky, Russia	1 10 0	1 1 3
Tanganyika, Congo and Rhodesia	4 18 9	1 16 3
LEAD-ZINC:		
BROKEN HILL:		
Amalgamated Zinc	1 6 0	1 7 6
British Broken Hill	1 18 9	1 17 6
Broken Hill Proprietary (8s.)	2 2 0	3 1 3
Broken Hill Block 10 (£10)	1 1 3	1 3 9
Broken Hill North	2 7 6	2 11 3
Broken Hill South	2 2 6	2 10 0
Sulphide Corporation (15s.)	1 2 3	17 0
Zinc Corporation (10s.)	1 0 9	17 6
ASIA:		
Burma Corporation	8 16 3	10 5 0
Russian Mining	17 6	10 0
RHODESIA:		
Rhodesia Broken Hill (5s.)	12 6	11 0
TIN:		
Aramayo Francke, Bolivia	3 18 9	2 17 6
Bisichi, Nigeria	14 0	11 6
Briseis, Tasmania	5 0	4 3
Dolcoath, Cornwall	9 6	3 6
East Pool (5s.) Cornwall	17 0	13 0
Ex-Lands Nigeria (2s.), Nigeria	2 9	3 3
Geevor (10s.) Cornwall	1 0 3	12 6
Gopeng, Malay	2 1 3	1 17 6
Ipoh Dredging, Malay	1 1 0	14 3
Kamunting, Malaya	2 6 3	2 10 0
Kinta, Malaya	2 11 3	2 7 6
Malayan Tin Dredging, Malay	2 5 0	1 17 6
Mongu (10s.), Nigeria	19 0	17 6
Naraguta, Nigeria	17 0	10 0
N. N. Bauchi, Nigeria (10s.)	7 0	5 6
Pahang Consolidated (5s.), Malay	15 6	10 9
Rayfield, Nigeria	16 0	8 6
Renong Dredging, Siam	2 5 0	2 1 3
Ropp (4s.), Nigeria	1 0 6	8 3
Siamese Tin, Siam	3 2 6	3 2 6
South Crofty (5s.), Cornwall	13 9	13 9
Tehidy Minerals, Cornwall	1 3 0‡	17 6
Tekka, Malay	4 5 0‡	1 1 3§
Tekka-Taiping Malay	5 7 6	1 5 0§
Tronoh, Malay	2 6 3	1 17 6

* £4 shares split into 8 of 10s. each. † £1 shares split into 4 of 5s. each. ‡ 15s. paid up. § New shares.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers ; also reviews of new books, and abstracts of the yearly reports of mining companies.

PURIFYING CLAY BY ELECTRICAL OSMOSIS.

The *Journal* of the Royal Society of Arts for June 25 gives a report of a paper on the "Commercial Application of Electrical Osmosis," by J. S. Highfield, Dr. W. R. Ormandy, and D. Northall-Laurie. This paper is of considerable interest, as it shows how china-clay, particularly unsettleable or "colloid" clay, can be purified from pyrites, silica, and mica. This subject was briefly mentioned by Mr. H. F. Collins in the Magazine for last December in the course of his articles on the china-clay industry of the West of England.

The present paper commences with definitions of colloids and osmosis. For the purpose of the paper it is sufficient to remind readers that a substance is in colloid condition when it is in a very fine state of division and is held in suspension throughout water or other medium, the substance being called the "disperse phase" and the medium the "disperse medium."

Picton and Linden found that matter in colloidal suspension, when subjected to direct current of upwards of sixty volts between platinum electrodes, tended after a time to collect around either the anode or cathode, leaving a clear space around the cathode or anode respectively. They investigated this phenomenon and found it to be of general occurrence. It is known as "electrical osmose or cataphoresis." The polarity of the particles depends not only upon the constitution of the particles but on the nature and quantity of electrolytes present, and also upon the composition of the disperse medium in which they are suspended as the disperse phase. Thus, silicic acid is charged positively when in water, and negatively when in turpentine. Generally, the continual suspension of a colloid in the disperse medium is possible only when the colloidal particle retains an electrical charge. The particles possessing the charges of the same sign, either positive or negative, repel each other, and so cannot coalesce or coagulate together. They can be made to coalesce by subjecting them to an electric field by means of immersed electrodes, when they are attracted to the pole of sign opposite to their charge, and are so discharged. This is the industrial method used in the purification of clay. They can be made to coalesce by adding to the liquid an equal number of colloidal particles of opposite charge, when the two sets of particles mutually discharge one another. As an example, the addition to a colloidal suspension of arsenic sulphide of a colloidal suspension of a basic material, such as ferric hydrate, causes the precipitation of the two colloids. The quantity of one colloid required completely to precipitate another colloid of opposite charge varies with the composition of the precipitating colloid.

Another method of bringing about the coagulation of "peptized" particles is to add to the suspension a small quantity of a salt which in solution is subject to electrolytic dissociation. If the peptized particles carry an electro-negative charge, then the added electrolyte must be electro-positive; thus, bodies which are peptized by an alkali are precipitated by an acid. The deposition of the fine silt and mud carried down by rivers when the stream encounters the salt of the sea is, no doubt, due to the flocculation of the dispersed particles by the salt electrolyte.

In order that the phenomenon of electrical osmose can be shown, it is necessary first that the colloidal material in suspension should be broken up by giving each minute particle an electrical charge, thus preventing coalescence, that is to say, the suspension should be "peptized." Various materials can be peptized, each requiring different peptizing agents. Thus, gelatine is peptized by hot and not by cold water; gums by cold water; mastics in alcohol by large quantities of water; metals by fused metallic salts; hydrous oxides by caustic alkali.

After giving the foregoing general explanation, the authors proceed to refer to the purification of clay and similar materials. The commercial application of these phenomena to the purification of clay is due to the late Count Schwerin. He showed that the addition of small traces of alkali to a suspension of clay in water resulted in the suspension becoming highly mobile, the clay particles remaining for a long time in suspension, the pyrites, mica, free silica, and other impurities which are not peptized tending to fall through the suspension. Count Schwerin, in his patent specification, points out that bodies in suspension which tend to move to the cathode require an electrolyte of an acid character to be employed to bring about dispersion or peptization, but that bodies which tend to move to the anode require electrolytes of an alkaline character. It is further of interest to note that the original inventor not only shows that the addition of suitable electrolytes can be used to peptize the main matter in suspension to bring about increased fluidity with the object of allowing foreign matter to separate out by subsidence, but he also points out that if one substance is present in varying degrees of fineness, it is possible by the utilization of the same principles to bring about a separation of the fine particles from the coarse ones. Coalescence of the peptized particles in a clay slip can be produced by discharging the particles by the addition of acid to the suspension; the clay then settles in a gummy flocculated mass, carrying with it the fine impurities as previously explained. The action of the acid and alkali on the slip can be illustrated by reversing the method and allowing a thin stream of neutral clay slip to flow into a vessel containing on the one hand acid, and on the other alkali; in the first, the clay particles fall in a continuous solid stream and settle quickly; in the second, the clay particles spread out broadly and settle very slowly. There are many disadvantages to the flocculation of the clay by coagulating with electrolytes; certain fine impurities remain in suspension and are carried down with the flocculated clay, so that only partial purification is attained. The physical state of the clay is entirely altered, and the clay is left in a form difficult to collect and dry.

For these reasons, the electrical method of purification was developed. If, in the prepared suspension, two electrodes are immersed, and a difference of electrical potential be established between them, the clay particles move to the anode, where they discharge themselves and adhere as a coagulated mass, and the water is driven to the cathode, leaving the clay in a semi-dry state attached to the anode. The fine particles of silica, mica, pyrites, and other impurities either migrate to the cathode or are washed away by the water stream moving to the cathode. This is an example of using a direct electrical pressure to produce coalescence in a peptized suspension. The effect of the practical application of the process on clay is to remove particles of mica, silica, pyrites, and felspar, and to leave the clay substance in a satisfactory state for final drying.

The form given to the apparatus for the commercial purification of clay consists of a tank of suitable form, containing at the lower part two paddles, which serve to keep the suspension in agitation, and which direct it in a stream through the numerous small spaces in the cathode fixed immediately above, surrounding the lower half of the anode. The anode consists of a metal cylinder, revolving at a speed of about one revolution in three minutes, at a distance of about three-quarters of an inch from the cathode. A scraper removes the clay from the anode, whence it falls down a chute clear of the machine. The fresh clay suspension is fed into the lower part of the container, and the water effluent is returned to be mixed with fresh clay. A machine with a cylinder 2 ft. diameter and 5 ft. long produces about 1,000 tons of pure clay per annum. The clay in suspension, in passing through the laminated or perforated cathode, becomes negatively charged and is immediately attracted to the anode cylinder, the water being driven toward the cathode. There is thus obtained a dry layer of clay on the anode cylinder, and a watery zone of clay suspension round the cathode. Fresh clay entering the machine encounters the watery zone on its passage to the anode, in which zone the electro-osmotically indifferent particles such as pyrites, mica, and quartz, become freed from the clay, and are washed away with the effluent from the machine. The effluent with these particles also contains some clay. It is carried to a settling tank where the impurities quickly settle out, and thence to a blunger, or other mixing machine, where it takes up fresh clay and returns again to the machine through one or more settling tanks. The clay leaves the machine in the form of a blanket from $\frac{1}{4}$ in. to $\frac{1}{2}$ in. in thickness, from which all the water has been driven except about 25%, and in this form admits of ready drying when required.

The process is flexible and, therefore, lends itself to the treatment of many varieties of clay from which many different products are obtained. From some marls and fireclays, considerable quantities of pyrites are obtained, and from others silica in a very finely divided form is separated. From china-clay deposits, exceedingly fine mica and sand are extracted. Again, the clay particles themselves vary greatly in fineness, and the very fine particles can be separated from the coarser. This exceedingly fine clay is useful for many purposes, and doubtless many new applications for its use will arise. The finest particles of ball clay are almost jelly-like in fineness. The cost of working varies widely according to the class of clay treated. The electricity used varies from as low as 20 up to 70 units per ton of machine product.

METALLURGY IN NEW YORK DISTRICT.

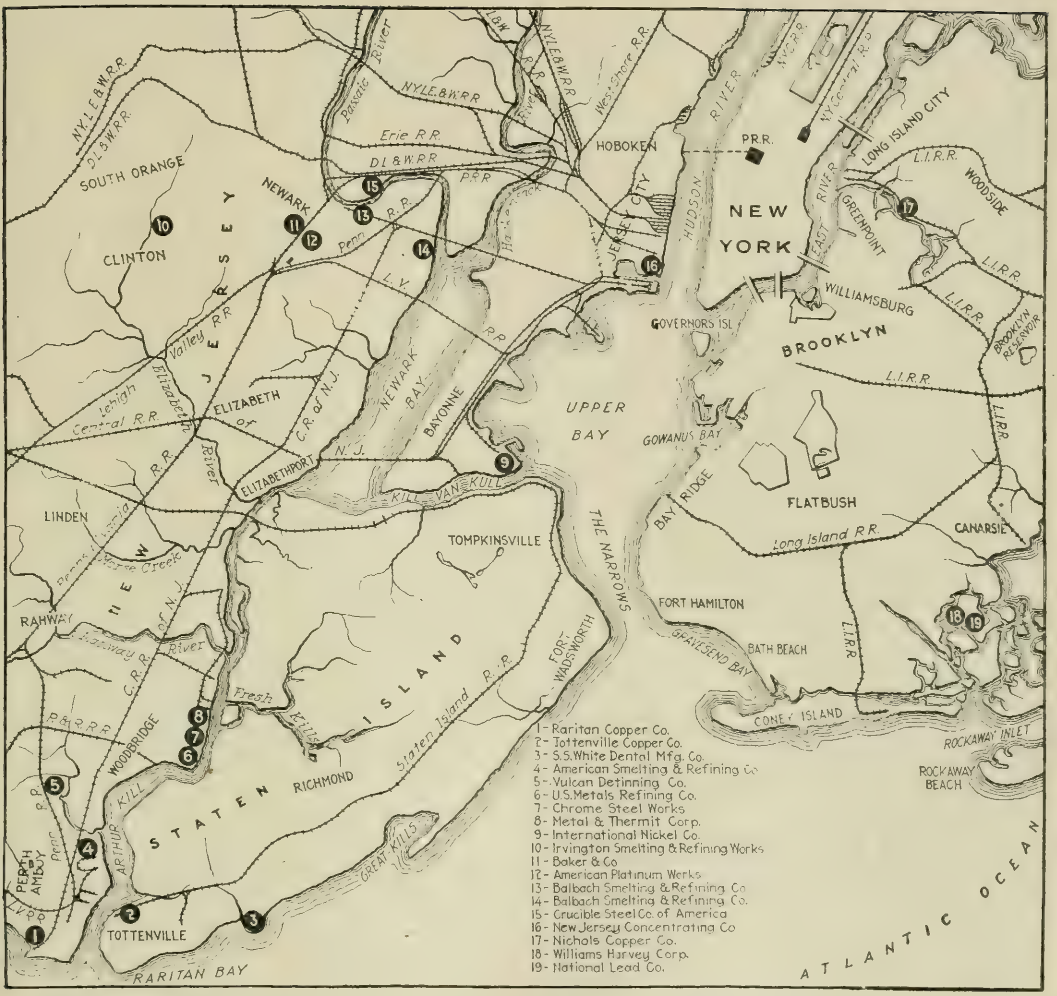
In the *Engineering and Mining Journal* for June 12, Edward H. Robie, the Journal's metallurgical editor, gives an account of the metallurgical works within thirty miles of New York. A real mine and mill—that of the Ramapo Ore Co., at Sterlington, N.Y.—is operating only twenty-eight miles from New York City. Iron from this mine, so the story goes, was used in making the chains which pulled George Washington's troops across the Hudson River. The mines of the New Jersey Zinc Co. at Franklin Furnace, N.J., are outside the 30-mile radius, being about forty miles from the city. The metallurgical operations within the radius consist chiefly of refining.

The Raritan Copper Works, at Perth Amboy, N.J., refines the blister copper and anodes from Anaconda and Miami as well as custom bullion, producing refined copper in all commercial shapes, together with silver, gold, copper sulphate, nickel sulphate, selenium, tellurium, tellurium oxide, platinum, and palladium. The furnace department contains six refining furnaces, with a capacity of about 2,300,000 lb. of copper per day, and five anode furnaces, which can take a slightly less amount. The electrolytic refining is carried on in two tank houses, No. 1 containing 1,800 lead-lined tanks, and No. 2 1,656 tanks. Silver and gold are parted electrolytically by the Thum and Moebius systems, the gold being refined by the Wohlwill process. The plant, when running to capacity, employs about 1,400 men and requires 14,000 kw. About 288,000,000 lb. of copper was produced in 1919.

The refinery of the Nichols Copper Co. at Laurel Hill, Long Island, handles the Phelps Dodge, Calumet & Arizona, and Granby products, and does a large custom business. The equipment includes a blast-furnace and converters, for a variety of material is received: matte from Mexico; ore and concentrate from Cuba; ore, matte and concentrate from South America and Africa; and blister copper from Arizona, Montana, and British Columbia. The electrolytic plant has 550 tanks and is operated on the series system. The principal products are refined copper and blue vitriol, the 1919 production being estimated at 310,000,000 lb. When running to capacity, which is about 550,000,000 lb. annually, about 5,600 kw. are used, and 1,600 men are employed.

The Perth Amboy, N.J., works of the American Smelting & Refining Co. are of considerable interest on account of their size and the variety of the processes employed. The plant was established about 1894 as a lead refinery. The Moebius electrolytic parting process was first employed there. The lead refinery was soon followed by a small copper refinery. Both have been greatly enlarged. In 1916 the first successful tin smelter and electrolytic tin refinery in the United States was started, and has been in continuous operation since that time. The plant handles a portion of the lead and copper bullion from the A. S. & R. properties in the United States and Mexico; copper bullion and mattes from South America; tin ores from South America and Alaska; and various lead and copper residues from all over the world. The finished products are necessarily varied. They include the precious metals; refined lead, copper, and tin; arsenic, sulphuric acid, hard lead, blue vitriol, and other metal products. The 1919 production was about 250,000 oz. of gold, 30,000,000 oz. of silver, 140 oz. of platinum, 125 oz. of palladium, 35,000 tons of lead, 70,000 tons of copper, and 7,500 tons of tin. About 1,800 men are employed when running to capacity, and 7,000 h.p. is then required. A recent installation of interest is a powdered-coal fired reverberatory refining furnace.

Another large refining works is that of the United States Metals Refining Co. at Chrome, N. J., fifteen miles south-west. This plant handles custom copper,



MAP TO ILLUSTRATE THE POSITION OF METALLURGICAL WORKS IN NEW YORK DISTRICT.

gold and silver ores, mattes and bullion; and scrap metals from Spain, Canada, Africa, Japan, Cuba, South America, and the United States. It gives employment to 1,200 men when the entire plant is running. There are two blast-furnaces, three converters, seven reverberatory refining furnaces, and 1,225 electrolytic tanks operated on the multiple system. The copper is cast on Walker wheels. The precious-metals department is equipped with a Cottrell treater for the flue gases. The 1919 production was roughly 80,000 tons of copper, 165,000 oz. of gold, 8,500,000 oz. of silver, 125 oz. of platinum, 250 oz. of palladium, and 1,000 tons of nickel sulphate. No selenium was produced, though this is ordinarily recovered.

The Balbach plant, in Newark, has several features of interest. The business was founded in 1852, when a small smelting plant was built on Passaic Avenue, which is now well within the city limits of Newark. The main plant is now situated on Newark Bay and is accessible to ocean-going vessels, besides having excellent rail facilities. It covers about fifty acres of ground, and comprises a copper-smelting plant, a lead-desilverizing plant, and an electrolytic refinery. The first-named is particularly interesting, as the work done is quite unlike that with which Western metallurgists are familiar. Scrap copper of various kinds is one of the chief ingredients of the charge. The stock-piles present quaint mixtures, including bird cages and dollar watches. The lead refinery is up-to-date, employing the Parkes process. The lead bullion used as raw material is secured from domestic and Mexican sources, and gold and silver and lead ores are also imported from South America. Miscellaneous drosses, residues, by-products, and doré bars are also handled. Production last year amounted to about 290,000 oz. of gold, over 10,000,000 oz. of silver, 1,500 oz. of platinum, 200 oz. of palladium, about 23,600 tons of lead, and 18,300 tons of refined copper.

The National Lead Co. has several interests in the vicinity of New York, but, in general, manufactures lead carbonate and oxides and performs special work, all of which comes outside the province of this article.

Tin smelting and refining is a comparatively recent industry in the United States. No publicity has been given as regards the methods used. The American Smelting & Refining Co.'s plant at Perth Amboy has already been mentioned. On the Mill Basin, Brooklyn, N. Y., the Williams Harvey Corporation has a smelting plant with a reported annual capacity of 20,000 tons, though only 4,000 to 5,000 tons of pig tin was produced last year. Two or three other companies are also interested in tin smelting; the Tottenville Copper Co. has a small plant, and the Andes Electin Corporation, of 35 Nassau St., is doing some work, so far largely of an experimental nature. The Vulcan Detinning Co. recovers tin and its salts from tinplate and scrap. Two reverberatory furnaces are included in the equipment, and the production is about 25,000 tons a year. The company has another plant in the West.

Most of the world's supply of nickel was, until recently, refined at the International Nickel Co.'s Bayonne works. Part of the International's refining is now done at the new plant at Port Colborne, Ontario, although the local works is still a large producer. The raw material is a converter matte from Copper Cliff, Ontario, containing about 25% copper and 54% nickel. This is treated by the Orford process, which consists in successive smeltings of the matte with nitre cake and coke, the resulting nickel and copper sulphides being separated on cooling the melt, by reason of their different specific gravities. Further purification and reduction to metallic form is accomplished in various operations, in which leaching, roasting, reverberatory-furnace smelting, and converting each plays a part. The refined nickel is produced in two forms, one a furnace product and the other as electrolytic nickel. Monel metal is also made, the sulphur being removed from the matte without separating the nickel and copper. The processes used are kept as secret as possible, although the Port Colborne refinery was recently opened to the members and guests of the Canadian Mining Institute.

Some competition in the nickel business is offered by the United States Nickel Co., which has a small plant at New Brunswick, N. J., about forty miles from New York, operating on raw material secured from sources other than the Sudbury deposits.

Platinum and palladium, together with their associated rare metals, are recovered and started on useful or ornamental careers in several plants near New York. In fact, New York may be said to be the centre of this industry in this country. A considerable quantity is recovered by the large refineries as a by-product, and a much larger supply is furnished by Colombia. Just now the platinum market seems to have collapsed, and the price has dropped below $100 per ounce, compared with $150 a short time ago. The pre-war price was about $45. The high value of platinum, and the small number of concerns in the business of refining and marketing the metal, combine to create a policy of secrecy, and visitors are decidedly unwelcome. Among the principal plants are the Irvington Smelting & Refining Works, Baker & Co., the American Platinum Works, Kastenhuber & Lehrfeld, and the S. S. White Dental Manufacturing Co. The United States Government assay office in New York should also be mentioned, as a large amount of precious metal is there handled, separated, and purified.

The Irvington plant is especially equipped to handle ores, concentrates, silver-gold-copper bullion, sweeps or any other material containing gold, silver, or the platinum metals. Some copper sulphate is also produced. The value of the product last year was nearly $10,000,000, and as many as 150 men have been employed. Baker & Co. work on the same character of material. Platinum, gold, and silver in practically all forms for the chemical, electrical, dental, jewelry, and kindred trades are sold. The American Platinum Works do much the same type of business, and treated about five million dollars' worth of precious metals last year. Kastenhuber & Lehrfeld have a plant in Newark in which high-grade ores, concentrates, and scrap are smelted in an oil-fired reverberatory furnace. The finished products are gold, silver, platinum, iridium, palladium, ruthenium, rhodium, and osmium. With the S. S. White Co., the refining of precious metals takes up only a small part of the plant. The raw materials handled in this department are gold bullion and dental scrap, and platinum ore, ingots, and dental scrap.

New York can hardly compete with Pittsburgh as a steel centre, but the Crucible Steel Co. has a plant (the Atha works) of no mean proportions at Harrison, N. J., across the Passaic River from Newark. The steel-making equipment includes several crucible furnaces, an acid and a basic open-hearth, and a five-ton Heroult electric furnace. The C. Pardee Works, at Perth Amboy, has two 25-ton and two 50-ton basic open-hearth furnaces; and Heller Bros. Co., in Newark, has a 30-pot crucible melting furnace. The Chrome Steel Works, a large plant at Chrome, N. J., is well known as a manufacturer of "Adamantine" chrome steel for the wearing parts of mining and milling machinery.

The New Jersey Concentrating Co. has a magnetic concentrator in Jersey City for treating wolfram, chrome, zinc, and similar ores.

THE SILVER ORES OF STEWART, BRITISH COLUMBIA.

In the Magazine for December last, particulars were given of the Premier silver-gold mine in the Salmon River district just north of Stewart, British Columbia. A discussion as to the nature of the high-grade silver ore found there is contained in the *Canadian Mining Journal* for June 4. The writer, Victor Dolmage, undertook a petrological examination of a number of specimens brought to the British Columbia branch of the Canadian Geological Survey by Charles Bunting, one of the original discoverers. Mr. Dolmage holds that these ores are primary, and are not secondary enrichments, as alleged by E. E. Campbell in the March Bulletin of the Canadian Mining Institute. Mr. Campbell's remarks were not quoted in the Magazine, owing to the Bulletin not reaching us. We give herewith a résumé of Mr. Dolmage's article.

Three classes of ore were represented in Mr. Bunting's collection, namely: (1) stephanite-native silver ore, which is the richest silver ore of the district, carrying as high as 3,000 oz. of silver to the ton (stephanite is a sulph-antimonide of silver); (2) a type which is known in the district as black sulphide ore, which carries from 500 to 1,000 oz. to the ton; and (3) lower-grade silicious ore.

The first class, stephanite ore, though exceedingly rich, is not abundantly distributed, but is confined to a few small veins less than a foot in width. In appearance it is quite spectacular, consisting of masses of stephanite and tetrahedrite cut by a close network of native silver veinlets and sprinkled through with a few small grains of pyrite. Gangue minerals are absent excepting for small inconspicuous grains of milky quartz. The microscope revealed the following minerals and structures in them, which indicate that they were deposited in the order named: pyrite, quartz, zinc-blende, tetrahedrite, chalcopyrite, galena, argentite, stephanite, polybasite, native silver, native gold. The pyrite occurs as sparsely scattered grains ranging in size from a few millimetres to a centimetre, which are invariably rounded, embayed and veined by replacements of quartz, blende, chalcopyrite, tetrahedrite, galena, native silver, and gold. Blende, though abundant in the black sulphide ore of the second class, is comparatively rare in the ore of this class, and is only visible under the microscope. It is sprinkled through with minute grains of chalcopyrite and is replaced by tetrahedrite and stephanite. Tetrahedrite is an abundant mineral in this ore. It is replaced by stephanite and native silver. Stephanite is the predominating mineral in this ore and constitutes at least 50% of the total volume of the specimens examined. It replaces the pyrite, blende, and tetrahedrite and is itself replaced by native silver. Polybasite is a rare mineral in these deposits and is found closely associated with stephanite and native silver. Native silver is abundantly present in this ore, occurring as small blebs in pyrite grains and as veins in the stephanite and tetrahedrite. These veinlets in some places have sharply defined contacts, and in other places they gradually merge into rich disseminations. Though assays show that this ore carries considerable gold, very little could be detected, even under the highest magnification. It was, however, observed as minute particles, both in the pyrite grains and in the gangue minerals free from other metallic minerals.

The second class of ore, known in the district as black sulphide ore, is the usual type of ore found in the workings. In hand specimens it is seen to consist of a dark-grey fine-grained mixture of gangue minerals, blende, galena, tetrahedrite, and pyrite. It is slightly porous, and the vugs are usually found to be lined with crystals of galena and drusy quartz. Under the microscope it was seen to contain the following minerals, which were deposited roughly in the order in which they are named: gangue (chiefly quartz), pyrite, quartz, blende, chalcopyrite, tetrahedrite, galena, argentite, native silver, gold. The similarity of this list to that of the stephanite ore is striking, the only difference being in the absence of polybasite and stephanite. The great difference in appearance is due to the much larger proportion of blende, galena, pyrite, and gangue, and a smaller proportion of native silver. The pyrite of this ore is precisely the same as the pyrite of the stephanite ore, being replaced in a similar manner by the same minerals. The blende is the most abundant mineral of the sulphide ore and, as usual, is impregnated with minute specks of chalcopyrite. It is also replaced by tetrahedrite, galena, and native silver. The chalcopyrite, which was confined to the blende in the stephanite ore, is in this ore freely distributed through the gangue and other minerals, but only as very small particles. Tetrahedrite and galena are both abundant in this ore, and though no silver minerals could be detected in them other than an occasional grain of silver, there can be little doubt that they are both argentiferous. The native silver of this ore, though not as abundant as that in the stephanite ore, is nevertheless plentiful. In this ore it never occurs in veinlets, such as those in the stephanite ore, but is always found in the form of small rounded grains in the galena, blende, tetrahedrite, and pyrite, usually showing a preference for pyrite and tetrahedrite. This mode of occurrence seems to indicate strongly that it was deposited in the same general period as the other sulphides and is therefore a primary mineral in this ore. Argentite is a rare mineral in this ore, and is associated with the other sulphides in a manner indicating that it also is a primary constituent.

The third class of ore is a strongly silicious type, consisting of white granular quartz with small scattered particles of pyrite, tetrahedrite, polybasite, stephanite, galena, argentite, ruby silver, and native silver. It is of low grade in comparison with the other ores, but is abundant in the district. All of the minerals are replaced to a marked degree by native silver, but the other minerals were not associated with one another, being distributed through the quartz as isolated grains, and their paragenesis is therefore not clear.

Of the minerals that have been identified in this deposit, the only ones that might be used as criteria for secondary enrichment are stephanite, pyrargyrite, and native silver. Stephanite has been proved to occur as a secondary mineral in a great many enriched deposits, and is generally regarded as a mineral characteristic of the enriched zone, but a possibly primary origin is admitted by many students of this subject. Its presence therefore may be regarded as a strong indication of secondary action, but not as conclusive proof. Pyrargyrite is a much more common constituent of secondarily enriched ores than stephanite, but it, too, has been found in mines at depths greater than those reached by surface solutions. Native silver was at one time thought to be invariably of secondary origin in sulphide ores, but it is not now regarded as such. In a recent paper on the Veins of Cobalt, Ontario, W. L. Whitehead has given proof of the primary nature of the native silver of those deposits. In the Stewart ore the native silver occupying rounded pockets in the pyrite, tetrahedrite, and galena is almost certainly of primary origin, while that forming veinlets in the stephanite may be of secondary origin. The impossibility of definitely determining the origin of this ore without an examination of the conditions obtaining in the field and without a study of the enclosing rocks and gangue is evident. Nevertheless, the above observations furnish evidence capable of supporting the following conclusions:

(*a*) The black sulphide ore is at the same time a very plentiful ore of the district, one of the highest-grade ores of the district, and one composed of essentially primary minerals. This establishes the important fact that much of the high-grade ore of the Stewart district is of primary origin, and has therefore a much better chance of persisting to relatively great depths than if it were of secondary origin, a fact of considerable significance in a camp so highly promising on the surface and as yet so slightly developed.

(*b*) The stephanite-native silver ore may have been enriched by the replacement of primary minerals by stephanite and native silver, and the silicious ore by the addition of ruby silver, stephanite, and native silver, but in neither case is it definitely proved.

(*c*) The small amount of stephanite ore to be found in the district, the comparatively low-grade character of the silicious ore, and the great preponderance of primary minerals over secondary minerals in all the ore excepting the stephanite ore, indicate that the processes of secondary enrichment may have played only a subordinate role, if any, in the formation of these rich silver deposits.

An interesting phenomenon observed in connection with the microscopic examination of these specimens, and one that served as an aid in determining the minerals, is the etching of the stephanite and native silver by the action of light. This peculiar property of silver minerals was first described by W. L. Whitehead (see Notes on the Technique of Mineralography, *Economic Geology* xii., 1917, page 707), who made observations on all the common silver minerals and recorded his results in tabular form, so that they could be used for purposes of identification. The stephanite of the Stewart disrict was found to be very susceptible to light, and on an exposure of from 10 to 30 seconds it would become covered with minute specks. Areas in the vicinity of silver veinlets and along scratches were found to be the most sensitive. It is a well-known fact in polishing that when a scratch is made on the surface of any material there is developed in the materal below the visible scratch a zone which, though not apparently affected, is nevertheless considerably modified so that it behaves differently under etching reagents. These modified zones vary in size and degree of modification with the size of the scratch that has produced them, and it is for this reason that spots etched on the surface of a polished mineral are sometimes found to be arranged in lines. These spots in one of the slides were of such a large size that an attempt was made to determine their character by the usual methods employed in mineralography. They were found to react with nitric acid and aqua regia in a manner similar to that of native silver, and their colour also resembled native silver. It is therefore probable that they are to some extent composed of this metal and that the effect of the light on the mineral is to dissociate it into its elements. This is, however, only a suggestion and far from being proved. The silver occupying the veinlets in stephanite was also in many instances found to be altered to a brownish red colour by the action of light, a peculiar feature not previously mentioned in mineralogical literature. The colouration was found to be confined to the smaller veinlets, to the margins of the larger veinlets, and was most strongly marked in the fine disseminations of silver in the stephanite. The phenomenon is thought to be the result of impurities in the silver, though this appears to be homogeneous under the highest powers of magnification. These facts show that the minerals stephanite and polybasite are very unstable, and it is therefore not surprising to find them so extensively replaced by native silver.

Professional Paper 104 of the United States Geological Survey on the Genesis of the Ores of Tonopah, Nevada, by Edson S. Bastin and Francis B. Laney, shows that stephanite, polybasite, pyrargyrite, argentite, etc., occur as primary minerals as well as secondary minerals in the ores of that district.

TIN DEPOSITS IN WESTERN ONTARIO.

In the *Canadian Mining Journal* for June 25, J. S. de Lury gives geological particulars of the occurrence of tin deposits near the Ontario-Manitoba boundary. In an article published in a recent issue of the Bulletin of the Canadian Mining Institute, attention was called by the author to the occurrence of tin in some bodies of sulphide minerals found in the vicinity of West Hawk and Star Lakes near the boundary line between Ontario and Manitoba. Since the writing of that article some additional information has been obtained in regard to these deposits. Attention is now called to them again, not on account of their commercial possibilities, for the tin is apparently not sufficiently abundant for profitable extraction, but by reason of the interesting manner of occurrence and the mineral associations.

The geology of the area in which the stanniferous sulphides occur has been briefly discussed by the writer in some articles in the *Canadian Mining Journal* in 1918 and 1919 written on the occurrence of molybdenum and tungsten in the same locality, and sketch maps were made showing the outcrops of rocks and geographical features, so that here only brief mention need be made of the relations between those rock units of the area which are of importance in connection with the ore minerals. The formations are similar to those described by Lawson as appearing in the Lake of the Woods District and are all of pre-Cambrian age. A biotite granite, mostly coarse-grained and reddish in appearance, is the youngest rock. It has intruded all the other types of the area. The ore minerals are found largely in a belt of schistose rocks which is bounded by the intrusive granite on either side. The schists are largely of the hornblende variety and were derived from basic lavas. Metamorphosed conglomerates and other sediments are also found in the belt. The granite body appears to have been the source of most of the ore minerals and, at different times during the later stages of cooling, there passed out from it mineral deposits of several forms and materials. There are some deposits in the locality which may not have been derived from the granite. In the list of occurrences which are now described, only those which appear to be directly attributable to the granite are mentioned. Pegmatite dykes are found in the schists, generally within a few hundred feet of the contact with granite. Molybdenite is the prominent economic mineral found occurring in the dykes; it is usually in crystals of good size. Masses of crystals have been found weighing 20 lb. or more, and some work done since the showings were examined is said to have exposed many masses even larger than these. A careful search for minerals of tin and tungsten was made in the excavations in the pegmatite dykes; but no trace of any of these was found. Aplite dykes are other off-shoots from the granite magma. They are not large, and the molybdenite in them is in small crystals and grains and is very irregularly distributed.

Two pegmatitic quartz veins have been found. They belong to a transition type between normal pegmatites and quartz veins. The economic minerals found in these deposits are gold, bismuth, bismuthinite, molybdenite, arsenopyrite, and small amounts of chalcopyrite. This association of minerals is identical with that reported of the contents of the Mikado mine, which lies in the western part of the Lake of the Woods district and only about ten miles south-east of these deposits. There is consequently a strong probability that the Mikado vein and perhaps many of the other quartz veins found in the Lake of the Woods district are directly attributable to the intrusion of the same granite that produced the mineralization in the boundary area and which is believed to extend into the Lake of the Woods.

In some porphyries derived from the granite magma and in adjoining masses of schist are some wide bands occupied by quartz and fractured country-rock filled with quartz stringers and carrying fine-grained molybdenite and small amounts of pyrite and chalcopyrite. Channel samples of this material, taken across considerable widths give assays showing a molybdenite content up to 1%, and values in gold, silver, and copper totalling about two dollars to the ton. Very little work has been done on this type of deposit, though considering the possible extent of them and the possibility of finding other and richer bodies of the same nature, it would seem well worth while to investigate the deposits already found and to conduct a search for more.

Scheelite-bearing deposits seem to have been given off from the granite at a later stage than the deposits that have already been mentioned. Scheelite occurs in altered bands and patches in the hornblende schist in company with epidote, vesuvianite, felspar, and other high-temperature minerals. Small amounts of molybdenite, pyrrhotite, chalcopyrite, sphene, and ilmenite are also associated, as well as calcite and quartz.

Sulphide-bearing zones in schist are numerous and large. They are found chiefly in the vicinity of West Hawk and Star lakes. The abundant sulphide is pyrrhotite. Pyrite is fairly general in occurrence and in places is abundant. Other minerals found irregularly distributed and in varying though usually small quantity are arsenopyrite, blende, galena, chalcopyrite, scheelite, and its high-temperature associates, quartz, calcite, and siderite. Low nickel assays have been reported from some of the pyrrhotite. The most interesting feature of these sulphide deposits is the presence of small quantities of tin.

Neil Martin, a prospector who has been in this part of the country since the boom days of the Lake of the Woods district, has for years been roasting samples from these sulphide deposits in his stove and has been obtaining beads of metal from them. Samples of these metals were sent by Mr. Martin to different assayers, and tin was reported from some of them. Unfortunately the people whom Mr. Martin informed of this were sceptical and hinted at tin cans, etc., as being the source of the metal. Though samples from the same places as those which furnished the tin were sent to many assayers, no tin was reported. Of the metal samples originally handed to the writer, the first ones examined contained lead or a mixture of lead and zinc, but one was examined which consisted mainly of tin. An examination of the deposits was then made to ascertain if possible in what mineral the tin is carried. This was difficult as most of the sulphides are intimately mixed. Many tests were made and, of all of them, the original method adopted by Mr. Martin was the most successful. In only one case was a definite mineral found which gave a satisfactory test for tin. This was a sample of what appeared to be chalcopyrite; a good blowpipe test was obtained from this, indicating that the mineral is a member of the isomorphous group between chalcopyrite and stannite. Unfortunately not enough material was left for a complete analysis, but it is hoped that more will be obtained.

Samples from the sulphide lodes were sent to be assayed. Most of the returns show less than 1% of tin; a typical set of samples showed 0·18, 0·18, 0·00, and 0·30% of the metal. Mr. Martin deserves credit for his persistence and ability in demonstrating the existence of tin, and the public who doubted his findings owe him an apology and a deal of praise. Though a careful search has been made in many of the more promising places, no cassiterite has yet been found in the area.

The writer has not completed his examination of the sulphide bodies, so that the following ideas concerning their origin must not be regarded as final conclusions, though the evidence is strong that they are correct. The fact that the molybdenite came from the granite is obvious. The association of this mineral with scheelite, bismuth minerals, and gold connects the deposits carrying these metals also with the granite. The occurrence of scheelite in the sulphide lodes points to the granite as the source of the sulphides. Finally, the presence of tin, so generally associated with granites and so commonly found with tungsten and molybdenite, shows beyond much doubt that many of the constituents of the sulphide lodes came from the granite. That the sulphide lodes are subsequent to the granite in their formation is indicated by the fact that a pegmatite dyke, apparently an off-shoot from the granite, is seen at one place to be impregnated and partly replaced by sulphides connected with one of the principal deposits.

It has been pointed out that the associations of minerals indicate a similarity in origin between the gold-bearing veins of the Lake of the Woods and the mineral deposits of the district near the boundary, which have been connected with the intrusion of a particular granite. It would be expected that this same granite would be found in the Lake of the Woods. Lawson's description of the granites of that area leads to the belief that this inference is correct.

There is reason for hope that deposits of tin and of tungsten will be found in the Lake of the Woods area. The wide distribution of molybdenite there adds considerably to the hope. It is more doubtful that commercial deposits will be found. Many of the larger deposits near the boundary appear to be too low-grade and the richer ones are generally too small to be considered. It is to be hoped that some of the bodies already found will prove to have the right combination of size and richness to be workable and that further prospecting in the Lake of the Woods area will bring some more of these interesting deposits to light. The general attitude of apathy and condemnation assumed towards the Lake of the Woods country is not altogether warranted.

Mineral Development in India.—The report of the Geological Survey of India for 1919 contains information regarding the progress of inquiries into the economic value of certain mineral deposits. An examination of the bauxite deposits has been undertaken owing to the attention which is now being paid to the manufacture of alumina and aluminium in the country. It is hoped to complete the greater part of the field work by the end of the season 1919–20, and to publish a memoir on the subject later. In consequence of the discovery of a new locality for chromite near Fort Sandeman in Baluchistan, it was decided to resume the survey of the area between Zhob and Hindubagh. Unfortunately the outbreak of the Afghan war interrupted the work of the officer deputed to undertake it, and only a short visit was possible. The samples collected represent second grade ores, but the occurrences are important because they prove the presence of chrome-bearing basic rocks, similar to those of Hindubagh, and suggest the possibility of further discoveries of chromite. Boring for coal below the Deccan trap has been undertaken at Bhusawal by the Great Indian Peninsula Railway Company. In November, 1919, the boring had reached a depth of 255 ft., of which 46 ft. was in alluvium and the rest in Deccan trap.

An officer of the Survey has been investigating the recent discoveries of iron ore in the southern parts of Singhbhum for the past two field seasons. The iron ore was found to occur usually at or near the tops of hills, the most important being the range running from about 3 miles south-west of Gua to the Kolhan-Keonjhar boundary east of Naogaon, a distance of about 10 miles. The range, which rises some 1,500 ft. above the plain, is said also to continue into the Keonjhar State. It was found that good iron ore formed the top of this range of hills almost without a break. Parallel to this range is another similar line of hills running from the Duargui stream, three miles east of Bada, to the Karo river south-east of Ghatkuri, a distance of about 7 miles. Here the iron ore was found to occupy the top of the ridge as before, the ore in the southern part being apparently as good and continuous as in the adjoining range; toward the north, however, a considerable amount of disturbance was observed, and replacement appeared to be less complete. To the west a third range of hills runs from the Karo river, east of Salai, to the east of Chota

Nagra. Here also iron ore was found at or near the top of the range, but it appears to be confined to patches, which, however, are of considerable importance. To the west of these ranges again are more irregular patches of ore occupying the tops of the hills. The Kolhan hematites usually appear to contain about 64% of iron, with phosphorus ranging from 0·03 to 0·08, or, in some cases, to as high as 0·15%. The sulphur content is usually below 0·03%. Titanium is also said to be found occasionally in the ore, usually either as a trace or in very small quantities. Samples from the better parts of the ore deposits contain as much as 68 or 69% iron. The concessionaires have done comparatively little prospecting work hitherto, but enough is known to justify the belief that the quantities available will run into hundreds—possibly into thousands—of millions of tons. In most cases the chief obstacle to development is the inaccessible nature of the country. The well-known magnetite deposits of Kanjamalai, in the Salem district of Madras, have been re-examined, and the conclusion arrived at twenty-two years ago has been confirmed, that the ore is really a low-grade quartz-magnetite schist containing about 38% of iron. Preliminary magnetic separation tests on bulk samples were not satisfactory, and the matter is under further investigation.

A well-known horizon in the Irrawaddy Sandstone Series of Upper Burma is known as the "White Bed," and it has long been recognized to contain a considerable amount of kaolin. Extensive examination of this bed in the Pakokku and Yamethin districts has proved it to contain very large quantities of clay, which appears to be eminently suitable for the manufacture of porcelain. The raw sand is said to contain about 60% of free silica, and from 25 to 30% of kaolin; it is also said to be very free from iron and alkalis. Laboratory tests indicated that the plasticity, refractoriness, and colour of the levigated material were good. The white bed is said to run for a distance of some 40 miles. Its thickness is variable, and is said to range from 15 to 50 ft. The most important area is regarded as the Yenangyat and Singu oilfields, where the bed attains its maximum development. Owing to the proximity of the Yaw and Irrawaddy rivers, levigation could be easily carried out, while cheap water-carriage is available to Rangoon.

The urgent demand for mica having ceased soon after the armistice, it was decided to close down the Masnodih mines which were being worked by the Geological Survey. Dr. Pascoe's memoir on petroleum in the Punjab and North-West Frontier Province is now in the press. It contains references to all the recorded seepages, most of which were visited and examined. An inquiry into the soda deposits and industry in Sind has recently been made. The total output of crude trona averages approximately 1,000 tons per annum. It is used for washing and dyeing clothes, and in a number of small native industries. An examination of the old sulphur mines near Sanni, in Baluchistan, showed that there was likely to be only a small amount of sulphur available. Good shows of cassiterite have been obtained by panning the alluvial deposits of a number of tributaries of the Tenasserim River, in the eastern portion of the Tavoy district, Lower Burma. Owing to the absence of further demand for wolfram, the officers who had remained for some years continuously at Tavoy in order to advise on the best methods of increasing the output were recalled at the end of the usual field season. The report gives in detail the results of the progress of the systematic geological survey work in Bihar and Orissa, the Chindwara and Nagpur districts of the Central Provinces, and the Tavoy and Mergui districts in Burma.

For the foregoing abstract of the report we are indebted to Mr. J. Coggin Brown, a distinguished member of the Geological Survey of India, who is at present in London on business for his department.

Barium Pigments.—Some light is thrown on the composition of white pigments in a paper by S. Stewart, in the *Journal* of the Society of Chemical Industry for July 15, on the detection of natural barytes in lithopone and similar pigments. Lithopone, Orr's zinc white, and other pigments composed essentially of zinc sulphide and barium sulphate should contain the latter only in the precipitated form. Inferior qualities sometimes contain natural barytes, to the detriment of their covering power, owing to the large size of the particles of barytes as contrasted with those of the precipitated sulphate. Its opacity is less, and although, when used as an ingredient in ordinary paints, this is perhaps of secondary importance, it becomes a matter of serious consideration when its use leads to the production of a yellowish white. The miscroscope affords a convenient means for differentiating between natural and precipitated barium sulphate. The test is carried out as follows: A minute portion of the sample is spread on a miscroscope slide with a drop of water, dried, and examined with a ⅔ in. or ⅙ in. objective, the diaphragm being closed so as to give a dark background. If only precipitated barium sulphate be present, it appears as a very fine powder composed of minute crystals of uniform size; whereas if there is an admixture of natural barytes, even when very finely ground, transparent irregular pieces of greater size will appear. The certainty of the method is enhanced if the zinc sulphide present in the lithopone be first removed by treatment with dilute hydrochloric acid and potassium chlorate and the insoluble residue examined as above.

Differentiation and Ore Deposits.—In *The Geological Magazine* for July, the editor, R. H. Rastall, who is University Lecturer in Economic Geology at Cambridge, contributes a paper on differentiation and ore deposits. We give an abstract herewith, kindly prepared for the Magazine by the author.

Although most geologists are now agreed on the derivation of many primary ores from magmas by some process of differentiation, the arguments brought forward are to a large extent founded on the study of silicates, and much less attention has been paid by petrologists to the sulphides and oxides; the chief exception is J. H. L. Vogt, of Christiania, who has done invaluable work on the solubility of sulphides in slags. He has proved that silicates and sulphides show limited mutual solubility at ordinary furnace temperatures, the solubility increasing as the temperature rises. This idea may be applied conversely to explain the separation of sulphides, for example, those of Sudbury and Insizwa, from basic silicate magmas, which is thus a process of differentiation by limited miscibility.

Theories of differentiation may be divided into three categories, as follows: (1) differentiation by sinking of crystals in a liquid magma; (2) differentiation by diffusion of molecules in solution to the cooler margin of an igneous mass; (3) limited miscibility in the fused state, as before described. Loewinson Lessing and Daly have postulated the existence of two primitive magmas, acid (granitic) and basic (basaltic) respectively, but have not carried the argument farther back than this. Although there is as yet no proof available, it may be suggested that the partition of these two primitive magmas may be due to limited miscibility

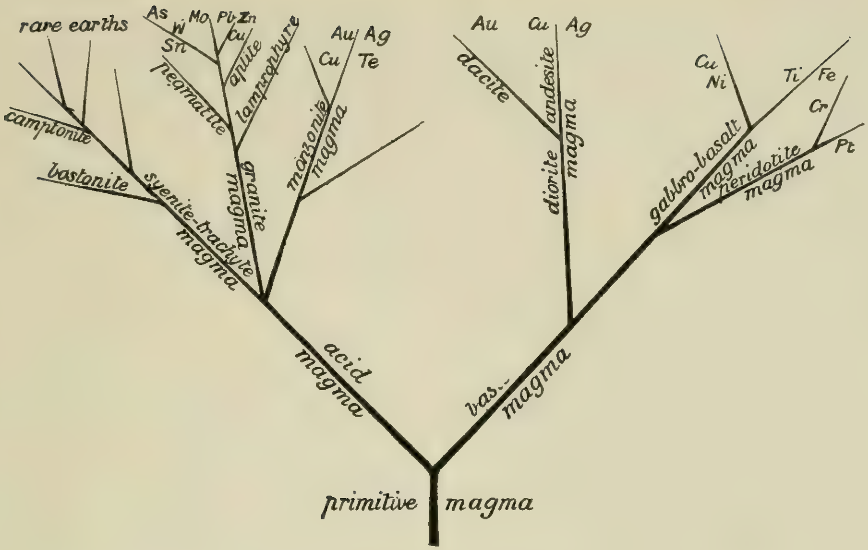


DIAGRAM TO ILLUSTRATE THE DIFFERENTIATION OF THE IGNEOUS ROCKS AND THEIR ACCOMPANYING ORE DEPOSITS.

of the constituents of acid and basic magmas.

Observation shows that certain metals tend to occur in association with particular rock-types; for instance, tin and tungsten with granites, nickel with gabbros and norites, chromium and platinum with peridotites, while others, such as copper and iron, are almost universal. When the magma is undergoing partition the metals must distribute themselves in the ratios of their partial solubilities, some being more soluble in acid, others in basic, magmas. As these partial magmas cool further the metallic compounds become less and less soluble; some form heavy compounds and sink, for instance, sulphides; others form volatile compounds and rise, for instance, fluorides; in either case the result is a stratification of the cooling magma. Thus we find nickeliferous sulphides at the base of basic intrusions and tin and tungsten minerals concentrated at the upper surfaces of granite bathyliths, along with the constituents of pegmatites and aplites, and silica, which eventually forms quartz veins. It may be pointed out, incidentally, that there is no real distinction genetically or mineralogically between pegmatites and quartz veins; many cases are known when the one can be traced into the other in a direction away from the main intrusion. It must be remembered also that these processes mostly take place above the critical temperature of water, 365°C, so that there is no real distinction between vapours and solutions, and many metals are undoubtedly conveyed into veins as volatile compounds and especially as fluorides.

When several metals are present in the magma, each will form a compound having its own solidification temperature and therefore capable of travelling only a certain distance into the surrounding rocks; we shall therefore have a series of ore-zones around a metalliferous intrusion, as in Cornwall. Thus the final separation of metallic minerals from the magma takes place in two stages; first a concentration in the last uncrystallized residue and then a translation along with this residue into dykes, veins, and lodes.

Basic magmas contain less volatile material and apparently less water. Hence there is a tendency for metals to remain more evenly disseminated, like chromium and platinum, or to sink like nickeliferous sulphides.

We are thus led to distinguish two types of ore deposits of direct magmatic origin; firstly, segregations within the mass itself, due to sinking, like the nickel of Sudbury and the iron of Kiruna, and secondly, the fissure deposits, dykes, lodes, veins, etc., formed by translation, usually upward or laterally and often extending beyond the boundaries of the basin; the best examples of this are afforded by tin, tungsten, bismuth, and arsenic, and a similar origin may be postulated for other metals, including copper, lead, zinc, antimony, mercury, silver, and gold.

The actual mechanism of differentiation in magmas is still a matter of discussion, and is of minor importance as compared with the fact that evidence derived from study of ore-deposits goes to show that some sort of differentiation must have occurred. The chief point of conflict is as to whether differentiation occurred before or during crystallization. It must obviously have taken place while part at any rate of the magma was still liquid, and in some cases sinking of solid crystals by gravity seems to be established, as in the so-called Palisade traps of New York and New Jersey, but in some instances the top of an intrusion is enriched in heavy minerals, which must have reached their present position by molecular diffusion in a liquid, as argued by Dr. Harker in the case of Carrock Fell.

In a diagram accompanying the paper, reproduced herewith, an attempt is made to give a preliminary idea of a genealogical tree of the igneous rocks and their accompanying ore-deposits, necessarily tentative, but founded on evidence available in the literature of metalliferous mining.

It is concluded that the processes of differentiation of rock-magmas, whatever they were, have been the dominant factor in the origin and primary distribution of the deposits of useful metals; later changes and secondary enrichments belong to subsequent stages of the earth's history and are governed by an entirely different set of factors not here considered.

SHORT NOTICES.

Winding Engines.—An article in *Engineering* for July 16 describes the winding engines made by Robey & Co., Ltd., of Lincoln.

Excavators.—At the July meeting of the Institution of Mechanical Engineers, F. H. Livens and W. Barnes read a paper on recent excavator practice.

Air-Lift Pumping.—In the *Engineering and Mining Journal* for July 10, G. J. Young describes the unwatering of a mine in Grass Valley, California, by means of the air-lift.

Flotation at Arizona Copper Co.'s Mines.—In the *Engineering and Mining Journal* for June 19, A. Crowfoot and E. Wittenau describe experimental work in connection with the all-flotation concentration of low-grade copper ore at one of the mines of the Arizona Copper Co., the cell used being of the Callow type.

Cottrell Precipitator.—A paper by A. B. Young is being presented at the August meeting of the American Institute of Mining and Metallurgical Engineers describing the electrolytic fume precipitator on the Cottrell system in use at the roasting furnaces of the Tooele lead smelters.

Zirconium.—The *Journal of Industrial and Engineering Chemistry* for July contains a paper by J. W. Marden and M. N. Rich giving the results of a number of researches into the preparation and analysis of various compounds and alloys of zirconium.

Pulverized Coal.—At the April meeting of the American Society of Mechanical Engineers, Otis L. McIntyre presented a paper on the use of pulverized coal in the Cerro de Pasco Copper Company's blast-furnaces and reverberatories.

Phosphoric Acid.—The *Journal of Industrial and Engineering Chemistry* for July contains an article by W. H. Waggaman and T. B. Turley on the production of phosphoric acid by heating rock phosphate with silica and carbon. This reaction is substantially the same as that employed in producing elemental phosphorus, but the element is allowed to burn.

Electric Smelting.—At the July meeting of the Society of Chemical Industry, Donald F. Campbell read a paper on recent developments of the electric furnace in Great Britain.

Smelter Smoke.—In *Chemical and Metallurgical Engineering* for June 23, E. E. Thum reviews a recent judgment allowing the continuance of the American Smelting & Refinery Co.'s smelter at Murray and the United States Smelting Co.'s smelter at Midvale, both in Utah. The author recounts what has been done to mitigate the fume nuisance, and gives details of an experimental farm inaugurated by the first-named company to ascertain the damage done to crops by SO_2 and the other constituents of discharge.

Cyaniding.—In the *Engineering and Mining Journal* for July 10, Douglas Lay writes on electric precipitation applied to cyanide solutions.

Oxygen in Metallurgy.—In *Chemical and Metallurgical Engineering* for July 14, F. G. Cottrell discusses the possibility of enriching air with oxygen in many metallurgical operations.

Copper-Nickel-Cobalt Mattes.—In the *Mining and Scientific Press* for July 10, R. G. Knickerbocker describes the separation of copper from a copper-cobalt-nickel matte at the works of the Missouri Cobalt Co., Fredericktown, Missouri.

Copper Assay.—In the *Engineering and Mining Journal* for July 24, F. G. Hawley describes a modification of the electrolytic copper assay.

Salting.—In the *Engineering and Mining Journal* for July 24, A. R. Ledoux writes on salting from the point of view of the assayer.

Graphite.—The *Canadian Mining Journal* for June 18 contains a fourth article by Charles Spearman on Canadian graphite.

Russian Petroleum.—In the *Engineering and Mining Journal* for June 19, Eugene M. Kayden reviews the present position of the Russian oilfields.

Hampton Plains.—*Chemical Engineering and Mining Review* (Melbourne) for May contains a paper by T. Butement on the geological features of Hampton Plains, West Australia, and the recent gold discoveries.

British Iron Ore.—*Economic Geology* for June contains a paper by Dr. F. H. Hatch on the development of iron ore in Great Britain during the war.

Nigerian Coal.—At the July meeting of the Midland Institute of Mining, Civil and Mechanical Engineers, J. S. Hayes read a paper on the Udi coalfield, Nigeria.

Swedish Iron Mines.—In the *Engineering and Mining Journal* for July 10, C. W. Boise describes the Kiruna and Gellivare iron mines in the north of Sweden.

Alaska Tin Deposits.—In the *Engineering and Mining Journal* for July 24, F. C. Fearing gives particulars of lode-tin deposits in Lost River district, near Cape Prince of Wales, Alaska.

Early Days on the Rand.—In the *Mining and Scientific Press* for July 10, J. E. Clennell gives his reminiscences of early days on the Rand.

The World's Supply of Energy.—The *Journal of the Franklin Institute* for July gives Professor Arrhenius' paper on the sources of the future supply of energy, a paper written in acknowledgment of the bestowal on the author of the Franklin Medal. We intend to quote from this paper in the next issue of the Magazine.

Electric Power.—The *Colliery Guardian*, in its issue of July 2, commences a series of articles on high-tension transmission of power in connection with mining.

Water-Power in Tasmania.—The *Engineer* for July 2 and 9 describes the hydro-electric station at the Great Lake, Tasmania.

Water-Flow.—The *Engineer* for July 9 describes the Rheograph water-flow recorder.

The Kalahari Desert.—The *Times Engineering Supplement* for July contains an article by Professor E. H. L. Schwarz on his proposed scheme for re-watering the Kalahari Desert.

African Rift Valleys.—The *Geographical Journal* for July contains a report of a lecture before the Royal Geographical Society by Professor J. W. Gregory on the rift valleys of eastern Africa. This lecture gave a résumé of Professor Gregory's investigations relating to the earth depression along a line of country starting from Palestine, passing down the Red Sea, and through the Great Lakes of Central Africa, to the Indian Ocean near Beira.

Crystal Structure.—*Nature* for July 22 gives an account of a lecture by Professor W. L. Bragg delivered before the Royal Institution on the theory of the structure of crystals as revealed by X-ray investigation. We gave an outline of an earlier paper on this subject in our issue of June, 1916, written by Professor W. H. Bragg, the father of W. L. Bragg.

The Gold Premium.—The May *Journal* of the Chemical, Metallurgical & Mining Society of South Africa contains a paper by S. Evans on the gold premium.

RECENT PATENTS PUBLISHED.

☞ *A Copy of the specification of any of the patents mentioned in this column can be obtained by sending 1s. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.2., with a note of the number and year of the patent.*

5,381 of 1919 (123,993). A. M. AYALA, Madrid. A solder for aluminium, consisting of 37 to 43% of zinc, 35 to 42% of tin, and 17 to 24% of lead.

5,580 of 1919 (143,973). J. S. ROSS, London. A modification of the method of extracting copper from oxidized ores by leaching with sulphuric acid.

5,923 of 1919 (144,762). S. P. BLACKMORE, Vaalhoek, Transvaal. A tool for securing the detonators to the fuse in the preparation of priming charges.

6,132 of 1919 (143,988). F. E. WALKER and C. H. HILL, Mansfield. Method of forming concrete slabs used in lining shafts, etc., so that they may be readily keyed together.

6,445 of 1919 (144,398). J. J. HOOD, London. Improved method of recovering cyanogen from coal-gas.

7,131 of 1919 (144,819). E. A. SPERRY, New York. Electrolytic cells for making certain lead salts, such as chromate, from metallic lead.

7,403 of 1919 (145,824). BALFOUR-GUTHRIE INVESTMENT CO., San Francisco. Method of producing cyanogen and ammonia by catalysis from hydrogen, nitrogen, carbon monoxide, and a hydrocarbon, by first exposing the catalyser to the mixture of gases at a high temperature, and subsequently, when the catalyser has become active by this high-temperature treatment, continuing the process at a much lower temperature.

7,956 of 1919 (145,852). L. A. WOOD and MINERALS SEPARATION, LTD., London. Method of differential flotation for separating chalcopyrite or other copper sulphide, graphite, coal, and molybdenite from iron, zinc, and lead sulphides.

8,165 of 1919 (145,870). MINERALS SEPARATION, LTD., London, and E. H. EMERSON, New York. For use in the froth-flotation process, apparatus comprising the combination with an agitation vessel of a pulp-intake conduit therefor, and a hydro-air injector delivering into the conduit.

7,584 of 1919 (145,159). R. HUSH, Johannesberg. Disc crushing machines used in laboratories.

8,881 of 1919 (144,022). L. W. DAMMAN, Zwolle, Holland. Mechanical method of removing earthy matter from rock-salt.

8,952 of 1919 (144,023). M. ALLEN, Manchester. Improved evaporating plant used in the production of salt from brine.

9,618 of 1919 (145,196). H. F. HEUMANN, Marissa, Illinois. Device for extending mine rails.

11,654 of 1919 (127,566). E. BERGVE, Notodden, Norway. Obtaining soluble compounds of potassium and aluminium from felspar by acting on it at high temperatures with sulphur vapour, whereby the oxygen in potash and alumina is replaced by sulphur.

11,688 of 1919 (145,925). H. L. SULMAN and W. B. BALLANTYNE, London. Improvements in the manufacture of rustless chrome-steel.

13,660 of 1919 (144,869). G. E. CLARK, Gateshead-on-Tyne. Improved apparatus for removing arsenic from sulphuric acid by the action of sulphuretted hydrogen.

14,094 of 1919 (145,956). A. E. FARMER, Birmingham. An alloy suitable for casting, drawing, and rolling containing 53 lb. copper, 28 lb. zinc, 25 lb. nickel, ½ lb. aluminium, and ½ lb. tin.

16,813 of 1919 (144,119). A. COHN, New York. Hardening platinum by the addition of small proportions of gold, say up to 5%.

17,630 of 1919 (144,896). ROPEWAYS, LTD., J. P. ROE, and H. F. H. SHIELDS. Improved form of boxhead guides for aerial ropeways.

19,734 of 1919 (145,297). W. W. RICHARDSON, London. Improved form of rifling in the inventor's trommel used in concentrating tin gravels.

19,978 of 1919 (144,142). J. L. FAIRRIE, Liverpool. A pyrites kiln consisting of a number of hearths arranged around a central flue for the gases.

26,253 of 1919 (134,531). NORSK HYDRO-ELEKTRISK KVŒLSTOFAKTIESELSKAB, Christiania, Norway. Precipitating alumina from aluminous solutions with ammonia under pressure.

728 of 1920 (145,366). W. CROWTHER, Manchester. A kiln for roasting spent oxide from the gas works for the production of sulphuric acid.

1,845 of 1920 (138,103). P. KÜHN, Dortmund, Germany. In blast-furnace regenerators, the use of coal dust as fuel.

NEW BOOKS, PAMPHLETS, Etc.

☛ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 723, Salisbury House, London Wall, E.C.2.

Geographic Tables and Formulas. Compiled by SAMUEL S. GARNETT. Fourth edition. Paper covers, 388 pages. Bulletin 650, U.S. Geological Survey, Washington.

The Use of the Panoramic Camera in Topographic Surveying. By JAMES W. BAGLEY. Paper covers, 88 pages, illustrated. Bulletin 657, U.S. Geological Survey, Washington.

The scope of the first of these useful Bulletins, both of which deal with topographic surveying, will best be gathered from a list of its chief contents.

Notes: Solution plane triangles, reduction to centre, three-point problem, meridian at any time by hour angle of Polaris, base line computations for steel tapes.

Tables: Azimuth of Polaris, convergence of meridians, projections for large areas, coordinates for projection of maps, areas of quadrilaterals of earth's surface, five-place logarithms of natural numbers, natural sines and cosines, five-place logarithms of circular functions, geodetic position computations, conversion of latitudes and departures in feet to seconds of latitude and longitude, differences of altitude for any minute up to 15 degrees and for any distance, distances and elevations form stadia readings, interconversion of miles and logarithms of metres, convenient equivalents.

Good arrangement and clear printing make the tables easy of reference. A stronger binding would increase the handling qualities of the volume and add to its length of service.

The second Bulletin is a valuable review of the applications of photogrammetry to surveying. To Laussedat, who began his investigations under the engineer corps of the French Army in 1849, belongs the credit for the first demonstration of the usefulness of phototopography. The Prussian general staff adopted the method in the campaign of 1870. Up to 1900 attention was directed mainly to the development of various forms of photo-theodolite. The panoramic camera was first employed by the brothers Wright, of the U.S. Geological Survey, in 1904, since when the author of the Bulletin has been instrumental in extending its use.

A great deal of photographic mapping has been carried out on the continent of North America, due to the efforts and influence of E. Deville, surveyor-general of Dominion lands, who in 1886 began systematic photo-topographic surveys in Western Canada. The literature of the subject is now considerable: important publications are those of Laussedat and Saconney (France), Flemer and Wright (U.S.A.), and Deville (Canada). The author of the Bulletin shows that the field cost when using the panoramic camera in conjunction with the plane-table is far lower than that of work executed with the plane-table alone; that though the office work is much more laborious with the photographic system, the final cost of the completed map is less; and that the results obtained with the camera are comparable in accuracy with those obtained with the plane-table.

Aircraft photography has won a secure position in military science, and on account of its potentialities as a means of map production is now claiming serious consideration for civil purposes. Experience in Palestine has demonstrated that one R.A.F. officer can without help complete a 1 : 40,000 sheet covering 20,000 yards by 28,000 yards in six weeks, using from 500 to 700 photographs; a rapid rate of progress which under favourable conditions will probably render the aerial method an economical one. The author gives a concise and critical account of five systems of aerial photography, varying from the reconnaissance of considerable precision to that of high rapidity but low relative accuracy.

The Bulletin is well illustrated with photographs, diagrams, and maps, and is altogether a stimulating production. ALEX. RICHARDSON.

The Nomenclature of Petrology. By DR. ARTHUR HOLMES. Cloth, small octavo, 284 pages, illustrated. Price 12s. 6d. net. London: Thomas Murby & Co.

This book comes as a godsend both to the economic geologist and the student. The number of new rock-names has grown to such an extent of recent years that the older glossaries are all out of date and a new glossary of petrological terms should receive a hearty welcome.

Dr. Holmes in his introduction is inclined to deprecate the modern habit of basing new rock-names on geographical names, and he states his preference for compound descriptive names in spite of their multisyllabic character. In this view most of us will sympathize, especially those who have not good reference libraries within reach. It is difficult, for instance, to see the advantage of calling a tourmalinized granite from the St. Austell district "luxulyanite," while one from the St. Ives district with almost exactly similar characters becomes "trevalganite." No doubt some will defend the geographical system on account of the association between the rock-name and the locality, but they will not, as a rule, be found among the ranks of economic geologists or mining engineers.

The introduction deals critically with the various attempts to establish a nomenclature based on a uniform principle, but the author pins his hopes of a systematic international nomenclature on the advent of some pre-eminent petrologist rather than on the decrees of any International Council.

The introduction is followed by a glossary giving the meaning or meanings of some 1,500 petrological names and affixes, with a reference to the original paper or publication in which the term first appeared in every possible case. This glossary appears to be remarkably complete for a first edition and does the author great credit. An inspection shows, however, that while luxulyanite is described trevalganite is omitted, and "peach" is defined but "capel" is not mentioned. These last two terms are widely used among mining engineers and it would be well to have them clearly defined in a work of reference as both have been used very loosely.

The glossary is followed by two appendices giving French and German petrographic terms, and these by two more giving Greek and Latin words and prefixes used in petrology.

The fifth appendix consists of a series of classification tables for the igneous, sedimentary, and metamorphic rocks and for products due to igneous exudations. The igneous rocks are classified according to silica content as oversaturated, saturated, and undersaturated. These tables form one of the best classifications yet published and, as the author points out, they serve to "bring out the patchiness of petrological nomenclature." They should help to suggest useful fields for further study of the rocks. It is cheerful to find ore deposits taking their proper place in a system of rock classification and not carefully shut off in a compartment of their own.

The classification tables are completed by one giving a classification of the meteorites by Dr. C. T. Prior.

The size of the book is convenient and the type is clear and suitably varied to set out the matter effectively. The author is to be congratulated on having filled a gap in geological literature successfully.

E. H. DAVISON.

Graphite. By HUGH S. SPENCE. Paper covers, octavo, 210 pages, with many illustrations. Ottawa: The Department of Mines.

Articles and books on graphite are rare, so that the new publication of the Canadian Geological Survey will be very welcome. The book contains a great deal of information relating to the Canadian deposits, with general accounts of methods of concentration and refining, estimation of value of the products, the uses of graphite, and the nature, occurrence, and origin of graphite deposits.

Prospecting for Oil and Gas. By L. S. PANYITY. Cloth, octavo, 250 pages, illustrated. Price 18s. net. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

Technical Methods of Ore Analysis. Eighth edition. By ALBERT H. LOW. Cloth, octavo, 390 pages, illustrated. Price 19s. net.

Mining and Preparing Graphite for Crucible Use. By G. D. DUB and F. G. MOSES. Bulletin 112 of the United States Mining Bureau.

Cadmium in 1919. By C. E. SIEBENTHAL. Pamphlet, 8 pages, published by the United States Geological Survey. This pamphlet gives details of the output of cadmium in the United States, together with information as to its sources and uses.

Report of the Coalfields Committee, India. Published by the Indian Government, Calcutta. This committee was appointed with a view to ascertaining whether it is not possible to improve the method of mining coal at the Indian collieries. The report is an elaborate one, and contains many opinions and suggestions from Mr. Treharne Rees, and from local managers and owners.

Refractory Materials: Second Edition. Being Vol. VI. of the Special Reports of the Geological Survey on the Mineral Resources of Great Britain. Price 7s. 6d. net. This volume deals with refractory materials obtainable in Great Britain, useful in iron and steel metallurgy.

Data of Geochemistry. By F. W. CLARKE Fourth Edition, revised and enlarged. Bulletin 695 of the United States Geological Survey.

Sources of Helium in the British Empire. By Professor J. C. McLENNAN. Bulletin 31 of the Canadian Department of Mines. This monograph contains an account of Professor McLennan's investigations, made during the war, into the supply of helium for use in air-ships.

Surveying. By W. NORMAN THOMAS. Cloth, octavo, 540 pages, illustrated. Price 31s. 6d. net. London: Edward Arnold.

Gold. By BENJAMIN WHITE. Cloth, small octavo, 130 pages, illustrated. Price 2s. 6d. net. London: Sir Isaac Pitman & Sons, Ltd.

Silver. By BENJAMIN WHITE. Cloth, small octavo, 140 pages, illustrated. Price 2s. 6d. net. London: Sir Isaac Pitman & Sons, Ltd.

Mica in the Eastern Transvaal. By A. L. HALL. Memoir No. 13 of the Geological Survey of the Union of South Africa.

Dictionary of Explosives. By ARTHUR MARSHALL. Cloth, octavo, 160 pages. Price 15s. net. London: J. & A. Churchill.

The Ownership and Valuation of Mineral Property. By SIR R. A. S. REDMAYNE and GILBERT STONE. Cloth, octavo, 260 pages. Price 12s. 6d. net. London: Longmans, Green & Co.

Liquid-Oxygen Explosives. By GEORGE S. RICE. Technical Paper 243 of the United States Bureau of Mines. This pamphlet gives particulars of the liquid-oxygen explosives employed by the Germans during the war, particularly in the coal and iron ore mines. An account of these explosives was given in the Magazine for April, 1916.

COMPANY REPORTS

Transvaal Gold Mining Estates.—The gold premium was largely responsible for the improvement in the financial results of this company operating in the Lydenburg district in the year ended March 31 last, as although the quantity of ore milled was increased the yield per ton was lower. The total tonnage from the three properties worked (the Central Mines, Elandsdrift, and Vaalhoek) was 190,060 (against 144,245 in 1918) for a gold yield of 71,374 oz. (against 55,381), the average being 7·511 dwt. (against 7·679 dwt.). The costs averaged 29s. 1·4d. (against 30s. 9·6d.) per ton, and the working profit 8s. 3·6d. (against 1s. 3·3d.) per ton. The profit for the year, including £55,318 from the gold premium, was £87,459 (against £15,552 for 1918 when no gold premium was obtainable) and the dividends paid (11¼% against 2½%) absorbed £67,975, taxes £8,834, capital expenditure £2,626, and debenture redemption £14,940. E. H. Clifford, the consulting engineer, referring to the continued fall in the yield of gold per ton, states that the Central Mines are entirely responsible for this fall, and adds: "Unfortunately, there are no grounds for anticipating any improvement in the yield, at least for the present, as very extensive prospecting operations in the Central Mines area have disclosed nothing but low-grade ore. The chief hope for the immediate future, therefore, lies in the reduction in operating costs." On the other hand, the position of the two outside mines (which have capacities of only ten stamps each) is described as much more satisfactory. At March 31 last the ore reserves were estimated at 662,754 tons averaging 8·6 dwt. (against 530,614 tons averaging 9·2 dwt. a year earlier). This total was made up of 501,392 tons of 7·44 dwt. ore at the Central Mines, 74,100 tons of 16·05 dwt. ore at Elandsdrift, and 87,262 tons of 8·69 dwt. ore at Vaalhoek.

Henderson's Transvaal Estates.—Besides extensive land and mineral rights in South Africa, this company has (directly or indirectly through the Henderson Consolidated Corporation) large holdings in subsidiary and other companies. These include Daggafontein Mines, Tweefontein United Collieries, and the recently formed British Asbestos Chrome Company. With regard to the Tweefontein United Collieries, the Henderson's report for the year ended March 31, 1920, states that the coal sales for the year ended September 30 last totalled 1,024,003 tons, the output being affected by the influenza epidemic in October, 1918, labour unrest in South Africa, and shortage of railway trucks. In view of the failure of the collieries to earn the profits anticipated when the combination scheme was carried out, Henderson's consulting engineer was sent out to look into matters, and he has now made his recommendations which have been approved by the Tweefontein United Collieries' directors. During the current year Henderson's Transvaal Estates has taken an interest in a property in Rhodesia on which large deposits of chrome and asbestos have been proved to exist. A. H. Ackermann has been appointed manager and consulting engineer of the new undertaking. At some future date, shareholders of Henderson's Transvaal, and those of the other companies interested in this business, will have a preferential opportunity of taking an individual interest in the company which has been registered as the British Asbestos Chrome Co., Ltd. Henderson's Transvaal Estates' net profit for 1919–20 was £45,892, against £49,002 for 1918–19, and the dividend is again 6% less tax. Reserve has been raised by £5,000 to £45,000.

H. E. Proprietary.—This is a finance company controlled by L. Ehrlich & Co., F. H. Hamilton being chairman, and E. T. McCarthy consulting engineer. It has large interests in the Piccadilly Hotel, Ltd., St. James's Court, Ltd., and the Channel Steel Co., Ltd. Among mining investments are holdings in New Lisbon Berlyn and the Palmarejo & Mexican Goldfields. The report for 1919 shows that the company has taken an interest in mining properties adjoining the Palmarejo. As already mentioned in the Magazine, the company owns the rights in the northern part of Klippoortje in the Heidelberg district, and is conducting boring operations conjointly with the Rhodesia Exploration Co., which owns the adjoining Maraisdrift. The accounts for the year show an income of £19,826, largely from dividends, while the net profit was £12,450, which has been placed to reserve.

Rhodesia Broken Hill Development.—After experimental work during part of 1916–17, lead production with two blast-furnaces commenced at this company's mine in north-western Rhodesia about the middle of 1917, and in 1919, the period covered by the latest directors' report, 33,084 tons of ore was smelted, producing 11,213 tons of lead. During the first half of the current year 7,280 tons of lead has been produced. All the ore for the smelters has been obtained by open quarrying at No. 1 Kopje. In the course of mining the smelting ore, 20,500 tons of zinciferous ore was broken and dumped for future treatment. The directors state that boring in the vicinity of No. 1 Kopje has proved considerable extensions to the east and north-west. The body of rich lead ore reaches the depth of 150 ft., with favourable prospects of continuance, and ore has been proved in two places 250 ft. apart at vertical depths of 300 ft. There is as yet no evidence of the limitation in depth of the ore-bodies. The ground has been cemented down to 170 ft., and the sinking of the main shaft reached 120 ft. in June. It is intended to cross-cut to the ore-body at the depth of 150 ft. Powerful pumps are to be installed at that depth toward the end of the year, as some heavy pumping is likely to be necessary before the ore-body can be entered and prepared for underground stoping. The erection of the two new furnaces is expected to be completed early next year. Two experienced metallurgists are now on the property devoting their attention to the testing and development of the most economical processes for recovering zinc. The profit and loss account for 1919 shows a profit of £100,889, after writing off £11,765 for depreciation, and the directors have recommended payment of a dividend of 10% (6d. per share) less tax, which requires £35,000. Sir Harry Ross Skinner and T. J. Milner have joined the board as representatives of the Central Mining & Investment Corporation, which has a large interest in the company.

Shamva Mines.—At Rhodesia's big low-grade gold mine, which is under Gold Fields control, a record quantity of ore was treated last year despite a loss of 16½ days in December through a strike. The tonnage crushed was 599,311 (against 556,881 in 1918) for a gold yield of 95,517 oz. valued at £475,849 (against £393,092). The recovery was 89·6%. The residues were slightly higher, sand showing an increase of 0·053 dwt. owing to harder ore and the larger tonnage treated causing time of treatment in the sand plant to be reduced. Mine rock has continued successfully to replace imported tube-mill pebbles. Working costs (excluding London office expenses) averaged 114·60d. per ton (against 118·13d. in 1918). The year's development footage amounted to 11,466 at a cost of £25,120. Cyril E. Parsons, the consulting engineer, writes that prospecting work was started to enable the management to gain some information regarding new ore-bodies in depth and in this direction £1,157 was spent. Also the prospecting of the claim area was continued mostly by trenching. In some cases it was found that payable ore was covered by from 10 to 30 ft. of valueless rock, so shafts are to be sunk to a depth of about 50 ft. in certain sections which are still to be prospected. The ore reserves at the end of 1919 were estimated at 1,982,000 tons valued at 4·3 dwt., a decline of 41,000 tons due entirely to curtailed development. In this connection the consulting engineer comments: "On this mine, with the assurance of so much undeveloped excess ore, it is not in my opinion a good policy or economical to develop too far ahead of our requirements. The volume of estimated ore available does not indicate the life of the property." Of last year's tonnage mined 273,000 tons averaging 3 dwt. came from excess areas. The accounts for 1919 show a profit of £178,484 (against £106,244 for 1918) and the dividends and bonus, amounting together to 22½%, absorbed £135,000. In respect of the current year two interim dividends have been paid at the rate of 30% per annum. Working costs having risen this year the directors have considered it desirable to counteract this tendency by increasing the capacity of the metallurgical plant. Eight more Nissen stamps are being installed, and when the additions to plant are completed it is expected to treat 56,000 tons of ore per month.

South Kalgurli Consolidated.—Owing to a strike and to labour shortage, the quantity of ore milled at this company's mine at Kalgoorlie during the year ended March 31 last dropped to 71,309 tons (against 96,239 tons in 1918), while working costs increased by 5s. 2·85d. to 28s. 10·99d. per ton. The gold produced was 23,044 oz., valued at £97,754 (against £128,557). The two months strike is calculated to have caused the company a loss of £3,275, and if it had not been for the gold premium, which yielded £18,021, the year's operations would have resulted in a loss. As it was, the profit amounted to £9,398 (against £9,603), and a dividend of 9d. per share, payable August 11, has been declared, which will absorb £9,375. This is the same return as for 1918–19. John Morgan, the consulting engineer, in his annual report, points out that in each succeeding year since the commencement of the war the development footage at the mine has gradually decreased, owing entirely to the shortage and condition of labour obtaining throughout the State during this period. Last year's development was 1,523 ft. against 1,716 ft. in the preceding period. The ore reserves at 190,934 tons, averaging 6·45 dwt., show an increase of 34,990 tons in quantity with a decline of 1·03 dwt. in value; in addition it is estimated that there is 94,246 tons of probable ore, worth approximately 5·68 dwt. per ton. The general manager, in a cable received in June last, however, states that having regard to recent developments, the grade of the blocked-out ore can be increased to 7½ dwt. The development work at the 13 and 15 levels main shaft on No. 3 east lode is described as very promising, "while the values encountered indicate that a large productive body of ore has been located, and in all probability its downward extension will be in due course established." F. G. Brinsden (of the Kalgurli gold mine) is succeeding J. M. Embleton as general manager of South Kalgurli this month.

Oroya Links.—This company, formerly known as Golden Links, owns leases on the Kalgoorlie goldfield. The report for 1919 states that the working of the leases by tributers was continued during that period as the policy best adapted to meet the conditions arising from the enhanced prices of all mining stores and the shortage and inefficiency of labour. During the strike the mill was overhauled. The quantity of ore extracted by tributers was 12,176 tons, of which 10,794 tons was treated at the company's plant and 1,382 tons at outside mills. The total quantity of ore treated at the company's plant, including ore purchased, was 15,289 tons. Working expenses amounted to 44s. 0½d. per ton milled. The company's total revenue for the past year was £110,566, and expenditure amounted to £99,062, leaving a profit on revenue account of £11,504. In the balance sheet there is shown a surplus of £73,060 realized on the sale of investments; out of this, £10,000 has been transferred to reserve account, £42,097 written off purchase of leasehold mines, £3,354 depreciation written off, and £17,608 written off balance of development account.

Consolidated Goldfields of New Zealand.—This company, besides having large share interests in the Blackwater and Progress mines, owns the Wealth of Nations mine, where a fire occurred in 1918 which completely destroyed the headgear and buildings at the Energetic shaft and seriously damaged the treatment plant. The report for 1919 states that the work of re-erecting the plant, &c., greatly delayed through scarcity of skilled labour, has now been completed, and the main shaft has been repaired. The completion of the plant as originally designed for the treatment of accumulated slimes, however, has had to be postponed in consequence of the present high cost of machinery and labour. As the higher costs at the mines the company is interested in necessitate a largely increased output in order to allow of the mines being worked at a fair profit, the directors have arranged for a certain number of miners to proceed to the mines from this country, it having been found impossible to secure the necessary men locally.

G. E. Stephenson, the new general manager, in his report on the Wealth of Nations mine, states that during the past year the balance of concentrates on hand at the mill, amounting to 33 tons, was treated with profitable results. The treatment of accumulated slimes was commenced in February with the plant, as originally designed, incomplete. Owing to the high cost of a suitable mechanically operated filter, it was decided to use the present sands vats as a filtering medium. The experiment, however, was not successful, and a low extraction resulted, due to the fact that the slimes after treatment contained a high percentage of moisture, this moisture being gold-bearing solution and a complete washing being necessary to displace it. Precipitation was difficult owing to improperly classified solutions, impurities in solution caused by direct treatment without washing, and acid salts from slimes. Throughout the treatment the slimes were shovelled and trammed from the dam at a much greater cost than would have been the case had a pump been installed. When the plant is finally completed and the mill is again in commission, working costs should be reduced considerably. The accounts for 1919 show receipts amounting to £1,374, and expenses £2,566.

Blackwater Mines.—At this New Zealand property, which is under the same control as the Progress, there was also a reduction of output last year, and costs were on a higher scale. The tonnage milled was 24,969 (against 31,728), and the total yield £52,612 (against £61,309), while expenses averaged 30s. 11d. per ton (against 24s. 4d.) Before deducting £5,061 for depreciation, £6,923 for development, and £2,172 for New Zealand income tax, there was a credit balance on the year's operations of £10,547. For 1918 there was a profit of £10,884 after writing off some £13,000. Reduced output (and consequent increase in working costs) is officially attributed to continued difficulty of obtaining an adequate supply of skilled labour, which also severely hampered development work. G. E. Stephenson, the general manager, gives the ore reserves as 87,562 milling tons of an average value of 10·29 dwt. over 35·9 in., an increase of 2,675 tons on the year, with a reduction of 0·55 dwt. in value. This estimate does not include certain small blocks under the floor of the levels and the shaft pillar which will not be removed till the end of the life of the mine. Referring to the fact that the outstanding feature of the year's work has been the development to the south of the shaft, the general manager comments that "these developments have practically opened up a new mine."

Progress Mines of New Zealand.—Labour shortage handicapped operations at this mine which belongs to the Consolidated Gold Fields of New Zealand group. A smaller quantity of ore was milled last year (15,980 tons against 16,320 tons in 1918), and it was again impossible to carry out any serious development work. The gold sold last year realized £19,926 and concentrates produced were valued at £3,493, but expenses amounted to £26,485, and £6,259 was written off development and as depreciation on plant, &c., leaving a debit on the year's working of £9,297. For 1918 the loss was £5,777. No dividend has been paid since October, 1910, when 9d. per share was distributed. The average grade of the ore treated last year was 7·016 dwt. per ton and the total recovery, including concentrates, was 80·8%. Costs averaged 28s. 6·62d. per ton, an increase of 1s. 8·66d. per ton, due to rise in wages and materials. G. E. Stephenson, the general manager, writes in his report that, speaking generally, the development work done during the year, with the exception of a small block in the hanging wall of No. 6 level, has disclosed nothing of any importance. There are strictly no ore reserves in the mine; the ore sent to the mill is obtained by stoping out the remains of the old blocks.

Briseis Tin.—Last year's operations of this company —which was formed in London in 1899 to take over properties being worked by a Tasmanian company— were on a considerably reduced scale. Work at Briseis was hampered by a diminished rainfall and it was not until early in December last that the diversion of the Ringarooma River into its second temporary channel was completed and a further block of lower drift made available for treatment. The average quantity of water available throughout the year was reduced to 88·5 sluice-heads (against 100 in 1918 and 140 in 1917). At Briseis 88,500 cubic yards of drift and over-burden (against 197,000 in 1918) was sluiced for a yield of 110·4 tons of black tin (against 256·85 tons); at Ringarooma 251,600 cubic yards of upper drift was sluiced (against 300,000) for a yield of 67·95 tons (against 64·15 tons); while the Mutual Hill area gave no return whereas in 1918 it yielded 7·6 tons from 38,953 cubic yards of drift sluiced. The total ground moved was 340,100 cubic yards (against 546,953) and the total output including tributes, 180·02 tons (against 328·6), the average metallic content being 73·1%. From the Briseis tin concentrate 19·30 oz. gold was saved. The tin sold realized £31,027, the average price obtained being £242, or £77 per ton less than in the preceding year. The profit and loss account for 1919 shows a credit balance of £3,198. Depreciation absorbed £2,416, Colonial taxes £1,630, and the 6d. per share dividend £15,000, so that whereas a credit balance of £13,840 was carried forward at the end of 1918, the company had a year later a debit balance of £2,007. David Currie, the consulting engineer, writing under date June 14, states that the block of ground made available by the second diversion of the river will now be worked, the tailings, together with those obtained from the removal of poor upper drifts from the Ringarooma section being utilized to build up a bank behind the present Krushka workings over which the river will run when finally re-diverted into its permanent channel. The amount of ground (lower drift) which has been rendered available by the last diversion is roughly estimated at 430,000 cubic yards which may be expected to yield approximately 500 tons of concentrate. How long it will take to work out this block will depend largely on the water-supply available, but also on the successful dumping and settling of the tailings, an operation which, if future trouble with the river is to be avoided, must be conducted with great care and deliberation. Several properties in New South Wales were examined during the past year, but the results were not sufficiently attractive. An alluvial gold deposit in Victoria is now being investigated.

Tin Fields of Northern Nigeria.—The average price realized by this company for its output of 115½ tons of tin concentrate in the year ended March 31 last was £164. 12s., an increase of nearly £20 per ton as compared with the previous year's price, and the report shows a profit of £5,644 (against £2,956). The directors have allocated £2,548 in reduction of the amount of £7,548 appearing in the 1918–19 balance-sheet to the debit of expenditure in Nigeria and London account, and have recommended a dividend of 7½% (against 15%), which requires £3,675, leaving £3,101 to be carried forward, subject to income tax. The consulting engineer in Nigeria, R. W. Hannam, writes that last year's output may be regarded as satisfactory, taking into consideration the rather light rainfall in the district and the difficulty of labour under the paper-currency system. A further six mining rights, totalling some 2½ linear miles, have been taken up on the Upper Fedderi. Elevating plants have now been brought into operation, and a recovery in the returns, which have been disappointing for the past few months owing to the exceptionally dry season and labour difficulties, is foreshadowed.

Lucky Chance Mines.—This company operates the Murgi alluvial tin property in the Bauchi province, Nigeria, and early in 1918 acquired the West Poldice tin and wolfram mine and dumps, east of Redruth, Cornwall. Through the Berrida company it is interested in the adjoining Poldice mine and dumps. S. R. Bastard is the chairman. The report for 1919 shows that 27¾ tons of tin concentrate was won from the Murgi property, and that a net profit of £708 was made. The stockwork on the Murgi property has not been proved to be payable. The company also has eight mining rights on the River Bilidi. As regards the Cornish ventures, these are at a standstill owing to the low prices of tin and wolfram, and the impossibility under the circumstances of raising the necessary working capital.

Mawchi Mines.—At this Burmese tin and wolfram property, where production commenced about the middle of 1914, 761¾ tons of mixed concentrate was won in the twelve months ended June 30, 1919, the period covered by the latest directors' report. In the preceding year 678 tons was produced. No sales were effected by the company between the cessation of the Government requisition of wolfram-bearing ores (March, 1919) and the end of the financial year, and the directors have submitted a claim to the Government for compensation. Liability for this has been repudiated, but the directors hope to obtain payment for the loss which the company has sustained owing to Government action. The accounts for 1918–19 show a gross profit of £29,535 and a net profit of £19,559, against £33,690 for 1917–18. With the balance from the previous year, there was at June 30, 1919, a sum available of £36,192, and the directors propose that the whole of this should be written off development account for the reason that the manager's report shows a decrease of 11,108 tons in the ore reserves, "and it appears doubtful whether the whole of this tonnage can be won at a profit." The output for 1919–20 was 1,026 tons. The Southern Shan States Syndicate (1909) Ltd., which owns the majority of the company's shares, having asked for further representation on the board, two of the directors voluntarily retired, and two mining engineers, C. M. Euan-Smith and J. D. Hoffmann, have been appointed in their places. C. M. Euan-Smith, who was the first manager of the Mawchi mine, has gone out to the property to take over control and to report fully to the board on the present position and prospects of development.

Burma Ruby.—The fortunes of this famous old mining enterprise, which works mines in Burma under a concession granted by the Secretary of State in Council of India, took a decidedly favourable turn in the twelve months ended February 29 last. The quantity of ruby earth washed was considerably lower than in the preceding year, namely 754,324 loads against 903,760 loads, and the cost per load was 3·8d. higher at 1s. 2·2d. per load, but the value of the stones mined amounted to £76,153 as compared with £44,168. This increase was largely due to the finding of the "Peace Ruby" in July. The directors state that the last six months of the year gave poor returns as compared with the opening six months, and the present high working costs have considerably reduced the profit. The local market for rubies in Burma and India was good all through the year, and in London the stock of stones was reduced from £11,910 to £7,590. The accounts show a profit of £30,572 (against a loss of £562 for previous year) from which the percentage payable to the Indian Government, amounting to £11,421, has to be deducted. An interim dividend of 6d. per share (free of tax) was paid on the ordinary shares last October, this being the first distribution since 1912–13.

Chile Copper.—At the well-known Chuquicamata property of the Chile Exploration Company (which is controlled by the Chile Copper Company of New York), 2,959,483 short tons of ore, averaging 1·62% copper, was sent to the treatment plant during 1919. The quantity actually crushed was 2,961,465 tons (against 3,745,083 tons in 1918), and 38,359 short tons of copper was produced (against 51,068 tons), the net recovery being 86%. Production was curtailed approximately 40% on account of the unsatisfactory condition of the copper market. The cost in cents per pound of copper produced was 13·01 last year (against 13·30 in 1918) and the cost of copper sold 15·10 (against 13·62). During 1919 Chilean exchange was more favourable than in 1918, which helped to reduce the cost of production. On the other hand, it is estimated that nearly all other factors entering into the cost of production were considerably higher last year. The combined accounts of the operating and holding companies show for last year a loss of $2,290,657, and a net deficit at December 31, 1919, of £287,794. It is pointed out, however, in the statement of Daniel Guggenheim, the president, that had the sales for future delivery of the company's large stock of refined copper been booked at sales instead of cost price the accounts of the operating company would have shown a substantial profit. Fred Hellmann, the consulting mining engineer, estimated the positive and probable ore at December 31, 1919, at 694,550,866 tons averaging 2·12% copper, the total being made up of 333,550,866 tons oxidized ore averaging 1·91%, 151,000,000 tons of mixed ore, averaging 2·98%, and 210,000,000 tons of sulphide ore containing 1·84%. The extension of the plant to a capacity of 15,000 tons of ore per day having been completed, it is now capable of producing between 145 and 155 million pounds of copper annually under normal operating conditions. The directors have deemed it conservative and wise to postpone further extension of plant, except certain features, until the world-wide economic readjustment has proceeded a little further, and, in particular, until the company's stock of copper has been sold, and evidence has been shown of a probable continuous sale of current monthly maximum output of the company's present plant.

Mond Nickel.—The report for the year ended April 30 last of this well-known nickel-mining and refining company, which has mines and smelters in Ontario and refining works at Clydach, near Swansea, shows a balance to the credit of profit and loss account of £531,295 (as against £320,428 for the previous year). The dividends on the ordinary shares for the year amount to 3s. 6d. per share, free of tax. Details of metal production and of other technical matters are not given in the report, but the directors state that the company's operations, both in Canada and England, proceeded on the reduced scale foreshadowed in the report issued last year. The large stocks of nickel which had accumulated at the end of the war have been substantially reduced during the year and steps have been taken to increase production at the Clydach works.

1 A

The Mining Magazine

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J. A. L. GALLARD, *Associate Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LIMITED AND REDUCED, AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938.* Telegraphic Address: *Oligoclase.* Codes: *McNeill*, both Editions.

BRANCH OFFICES: 420, Market Street, San Francisco. 300, Fisher Bdg., Chicago. 2,222, Equitable Building, New York.

SUBSCRIPTION: 16s. per annum (Single Copy 1s. 6d.) including postage to any part of the World.

Vol. XXIII. No. 3 LONDON, SEPTEMBER, 1920. PRICE 1s. 6d.

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EDITORIAL

THERE is on exhibit at the Jermyn Street Museum a collection of Burmese tin and wolfram ores lent by Dr. J. Morrow Campbell. As far as we know so many polished specimens have not been shown before. The collection is well worth a visit.

SIR Norman Lockyer, who died last month, was not only an eminent scientist but he was also a distinctly forceful leader of thought. He was, indeed, one of the demi-gods in the heroic age at South Kensington. In the obituary notices that have appeared in the general press, attention has been centred on his astronomical discoveries and his activities as an educationist. To our mind, however, the greatest service which he rendered to his fellow men was his foundation of *Nature,* the weekly periodical, which was from the first, and still is, far away ahead of anything else in the realm of scientific and technical journalism.

COLLEGE courses in engineering tend to increase in length. Three years used to be the standard, and the recent increase to four years gave rise to much perturbation in many quarters. Now we have Columbia University offering a six years' course, involving four years of general study, to be followed by two years of specialized training. Undoubtedly such courses will produce technical men of higher scientific attainments and insight, and their establishment will tend to accentuate the difference between the university and the technical school.

WHILE writing of technical education, it is interesting to note that the big firms in this country continue to found scholarships which enable the promising youngsters to improve their position. The two firms of shipbuilders and marine engineers, Swan, Hunter, & Wigham Richardson, of Newcastle-on-Tyne, and Barclay, Curle & Co., of the Clyde, have recently combined to establish four such scholarships, two in naval architecture, and two in marine engineering, tenable for three years at the Armstrong College, Newcastle, the University of Glasgow, or at any other approved educational institution. These scholarships are open to the firms' employees under the age of eighteen. Their value will cover the cost of university fees and of books and instruments, and will include a subsistence allowance of £2 per week during the university session. Thus the humblest apprentice will have the opportunity of obtaining a university education qualifying for a degree.

PROPOSALS to use aluminium-brass instead of silver for coinage purposes in France are being received without enthusiasm. For one thing, it is felt that the coins will be easily reproduced illicitly. Moreover, the alloy cannot be employed officially by the Government, as its use is precluded by the Latin Monetary Convention. To get out of the difficulty, the French Government is asking the Chambers of Commerce to manufacture and father the new coins, which will be regarded merely as local trading tokens, and contain no impression connecting them with the State. It is doubtful whether the proposals will be adopted.

A German research association in Berlin has revived the proposal to extract gold from sea-water and is inviting subscriptions to its capital. During the last twenty-five years this source of gold has formed the subject of more or less serious experiment; on one occasion, by a man called Jerningham, off the New England coast, and on the other by Mr. F. L. Rawson, off the eastern end of the Isle of Wight. The gold content of the sea is so low that the process is, of course, quite out of the range of commercial operations at present. Theoretically there is no intrinsic reason why some cheap automatic method should not be discovered eventually, but it is a trite enough saying that scientists and investors must always tread warily whenever a promoter comes round offering to make fortunes for them in this way.

CRUDE oil has been used or tested as a fuel for locomotives on many occasions, and in particular the Great Eastern Railway's experiments of a dozen or more years ago are worthy of special mention. That these locomotives were subsequently withdrawn was not so much caused by the unsuitability of oil for this purpose as the excessive heaviness of the engines built on this system. The London & North Western Railway has this month started to employ oil-driven engines on the Birmingham and London expresses, after having first conducted extensive tests on goods engines. The system adopted is that known as the "Scarab," and it is stated that it can be applied to any locomotive within a few days and at little cost. The consumption works out at about 10 lb. of oil per 100 tons per mile, and no difficulties are experienced in maintaining steam. Nothing has been heard recently of the coal-dust locomotive tested on the Great Central Railway, so oil is once more ahead.

THE *Engineering and Mining Journal* is going ahead with its shaft-sinking competition, to which reference was made in these columns last June. The committee to judge the records has now been appointed, and consists of Messrs. George S. Rice, W. Y. Westervelt, and D. E. A. Charlton, who have been nominated respectively by the Director of the United States Bureau of Mines, the Secretary of the American Mining Congress, and the Editor of the *Engineering and Mining Journal*. The terms of the award limit the competing sinking records to those made subsequent to the *Journal's* announcement in its issue of May 15 last and specify shafts steeper than 45°; but they say nothing of the size and shape of the shaft or of the depth at which the work was done, nor of the nature of the rock excavated, the distance and time being the only factors that count. Though it has been impossible to evolve a scheme of award based on all the points of merit, it may be hoped that the competitors will give full details of the conditions in each case.

Mining Research.

In this issue we publish an article by Mr. Alex. Richardson, Principal of the Camborne Mining School, urging that the metal-mining profession should organize research. As an old Camborne student and as a Rand engineer, Mr. Richardson has had many opportunities for observing the lack of scientific spirit at the mines. The metallurgical branch of the work provides facilities for research, and the ablest chemists devote their energies and knowledge to the problems involved; but as a rule there is no department devoted to the elucidation of mining questions, and investigations of this nature are usually undertaken as personal hobbies. This lack of encouragement for research in connection with mining problems has recently impressed itself on Mr. William Frecheville, lately professor of mining at the Royal School of Mines, and he has founded scholarships with the object of affording the opportunities that have hitherto been wanting. His public-spirited action cannot be too widely known, and his example should be followed by others. Mr. Richardson, who holds a position at Camborne similar to that held by Mr. Frecheville at South Kensington, is just as keen in advocating the establishment of mining research on systematic lines. The article which we print on another page may be regarded as introductory to the subject. Possibly he may enlarge on details at a later date and indicate specific points where investigation is desirable. Certainly he ought to introduce the matter at a meeting of the Institution of Mining and Metallurgy, and also invite the friendly assistance of the various Chambers of Mines. It is hardly necessary to add that contributions to the discussion of the subject would be gladly welcomed in the pages of the MAGAZINE.

Though we have said that mining research is usually neglected, there are notable exceptions. At one time the controlling houses on the Rand had a joint research committee, and many problems were investigated to advantage. This organization has, however, been dissolved. The West Australian mines did something on the same lines, and several firms of mining engineers and mine managers have members of their staffs whose time is largely occupied in this direction. In the English mining schools, however, little research has been done, for as a rule the professors and lecturers have been too much occupied in their teaching duties to find time for original work, while those who are not full-time teachers have been encouraged rather to eke out their modest salaries by accepting outside professional commissions. A case in point is provided by the late Sir Clement Le Neve Foster, who combined the professorship of mining at South Kensington with the position of Chief Inspector of Mines for the United Kingdom. Research in connection with mining is not, however, confined to the schools and the mines, for the makers of machinery, plant, etc., devote much of their time to the scientific investigation of power problems, rock-drilling, explosive manufacture, pumping, and hoisting; but the activities of the manufacturing firms are often hindered or made difficult by want of co-operation on the part of the mine-owners, the exact problems to be solved and the requirements of the users being thus often unknown or unappreciated by the makers. Then again it has to be remembered that mining is such an uncertain business and research in connection with it is so expensive that the directors and managers seldom feel justified in devoting funds to original investigations, preferring to tread on the well-beaten paths of practice. Altogether it is a difficult matter, this mining research; if it had been easier it would have solved itself ere this. Nevertheless something strenuous must be done if metals and minerals are still to be got, and, among other methods of attaining this end, the university and school must help the mines by undertaking research at home, or by sending the expert scientific investigator to tackle the problems on the spot.

The Corrosion of Building Stones.

The appeal for funds whereby the ravages of time and the atmosphere may be made good at Westminster Abbey has raised again the question of quality and beauty in building and the comparative lives of various stones. The columns of *The Times* have contained many interesting contributions on the subject, of which those by Professor Cecil Desch, of Sheffield University, and by Mr. J. Allen Howe, curator of Jermyn Street Museum, appeal the most to mining men. The immediate question is how to preserve an ornamental stone in a town atmosphere which is vitiated by acids, particularly the acids arising from the consumption of sulphury coal. Naturally a great many factors are involved. If permanence were the only consideration, Delank granite or Penmaenmawr diorite would do admirably, but such stones are better suited to a Scottish baronial hall than a cathedral. King's College Chapel, York Minster, or the many beautiful churches seen by the British and American armies in France and Belgium could not be made of granite. Millstone Grit and Pennant Sandstone are equally uninspiring. It is no labour of love to pile big blocks one on top of the other, as at the Pyramids, the Whitehall cenotaph, or the threatened Hyde Park paganism. The best and most beautiful stone must be used for Christ's house, and for its fashioning it must be capable of responding to the exercise of the highest human talent. Thus there is no alternative to the oolitic limestone, of which that coming from Portland in Dorset is the best obtainable in England. Though not immune from atmospheric attack, its behaviour in this connection is regular and perfectly well understood. As an alternative for stone, the use of glazed facings has been recommended, but these of course do not lend themselves to the processes of carving and sculpture. Such structures would be too reminiscent of drain-pipes, and would resemble the real thing as much as glacier gelatine resembles stained glass. Other proposals involve the use of surface washes applied to the real stone. Lime-wash offers little or no resistance to corrosion, though, as it can be applied continually, its presence checks the attack on the stone. Baryta has also been used, but it is unpleasant to handle, and the surface produced is as ugly as that of ordinary lime-wash. Silicate of soda has been tried, and it is found to afford little protection. Professor Desch draws attention to the fluosilicates, particularly that of magnesium. When magnesium fluosilicate is brushed over the surface of limestone, a reaction takes place, resulting in the formation of three insoluble substances, silica and the fluorides of calcium and magnesium. The fluosilicates have been extensively used on the Continent for preserving old buildings, but their use is not widely known here, and further investigation can be recommended. It can hardly be doubted that research in this direction will eventually disclose some preservative which will be effective without being offensive to the æsthetic sense, and that the mining geologist and the chemical engineer may yet come to the rescue of the fabric of Westminster Abbey.

John Perry.

Among the many distinguished professors at South Kensington none inspired more personal affection than the late John Perry, who was, from 1896 to his retirement in 1914, the professor of mechanics and mathematics in the Royal College of Science. He was versatile, volatile, argumentative, unorthodox, and a keen critic; he was a warm-hearted, sharp-witted Ulsterman, and an ever-ready helper as well as a critic; so everybody loved him in spite of his penetrating rapier. His spheres of activity were multitudinous, and in them all he left a permanent impression; but perhaps his most notable achievement was the popularizing of the higher mathematics. Before his time the applications of mathematics were, to a very great extent, in the hands of the mathematicians themselves, at any rate among the professional mathematicians; consequently the problems of astronomy and the physical sciences received chief attention in mathematical studies. The requirements of engineering construction were not fully appreciated by the mathematicians, so that the number of engineering mathematicians was limited. Those who did take up this line of study, such as Rankine, Osborne Reynolds, and Lord Kelvin, were mathematicians first and engineers afterward, and were above the heads of the average student. On the other hand, John Perry was an engineer before he was a mathematician, and his sympathies were with the worker rather than the theorist. He was thus able to evolve a course of mathematical study suitable for the average engineer and electrician, chiefly by simplifying co-ordinate geometry and limiting the study of the integral calculus to the first theorem in integration. Thus his lectures at South Kensington were on an entirely different basis from those at Cambridge. It is interesting to record in this connection the fact, which is not generally known, that he received more than one invitation from American educational institutions, these invitations being prompted as much by his curriculum as by his personal ability and attractiveness as a teacher.

Perry was born in Ulster in 1850, and was apprenticed at a local foundry. While there he gained a Whitworth Scholarship, and proceeded to Queen's College, Belfast. After taking the degree of Bachelor of Engineering, he received an appointment as instructor in physics at Clifton College, Bristol. Three years later he became assistant to Lord Kelvin (then Sir William Thomson) in Glasgow University. In 1878 he went, along with the late W. E. Ayrton and John Milne, to the Imperial College of Engineering in Japan. Here he stayed for four years, and during that time the names of Ayrton and Perry became world-famous in connection with electrical research. On his return to England he was appointed professor of mechanical engineering and applied mechanics in the City & Guilds Institute in Finsbury, and here also he had distinguished colleagues, of whom Silvanus Thompson, the professor of physics, was as eminent and versatile as himself. This institute was intended mainly for youths of the working class, and the teaching was conducted in the evening as well as in the daytime. The work done by Perry and Thompson was unique in its way. As lecturers they were unrivalled, and the beneficence of their influence was incalculable. After staying here fourteen years, he proceeded in 1896 to the Royal College of Science, where he held the professorship of mathematics and mechanics until 1914. Subsequently he went to South Africa to organize a scheme for the foundation of a university under the Beit bequest, and it is noteworthy that his scheme was adopted almost in its entirety.

Among his other activities, his long connection with the British Association in one capacity or another is worthy of mention. He was president of the Institution of Electrical Engineers and of the Physical Society. We have already referred to him as a keen and kindly critic; this characteristic made him the ideal man to open a discussion at a meeting of a scientific or technical society. Having such enlightened views as to the methods of teaching, it was natural that he could discuss educational methods with clarity and directness without losing his way or wandering in a circle, as other speakers on the subject are apt to do.

Perry was as distinguished in the walks of practical engineering as he was in the lecture theatre or at the scientific meeting. With his coadjutor Ayrton he did much to make the electrical accumulator a commercial success, and he invented the ammeter named after him and his partner. He constructed machinery for covering electric wire with gutta-percha insulation, and he built aerial ropeways. One of his pet subjects for popular lectures was spinning tops, and in recent years he applied the principles involved to the invention of the gyrostatic compass, in particular helping Mr. Sydney Brown in several points of the design of the compass to which we referred last April. Perry was not merely a scientist and engineer; he was an omniverous reader, and his acquaintance with the novel was surprisingly extensive. Altogether he was a charming man, one possessed of an original mind.

The Griffin Centenary.

It may be said without fear of contradiction that the house of Griffin has done more for the mining engineer and metallurgist than any other firm of publishers of technical and scientific books. Other publishers, such as Macmillan's, Crosby Lockwood, Wiley's, and the McGraw-Hill Company, and also several French and German firms, have issued many books of high quality, but Griffin's has published a greater number of standard works, and has maintained a steady reputation for a greater number of years than any of their competitors. Who does not know Le Neve Foster's Ore and Stone Mining, Gowland's Metallurgy, Park's Mining Geology, Beringer's Assaying, and Brough's Mine Surveying? In how many colleges and schools in the British Empire and the United States are these not the recognized text-books? In themselves these five books afford a liberal all-round education for the mining man. When in addition such books as Rose's Gold, Julian & Smart's Cyanide, Collins's Silver and Lead, Harbord's Steel, Turner's Iron, and Redwood's Petroleum are mentioned, the position of Griffin's among publishers may be readily grasped.

Griffin's has been in existence for a hundred years, and the occasion is marked by the issue of a handsome volume giving the history of the firm and its many activities. This has been prepared by Mr. Francis J. Blight, who has been the guiding spirit for the last quarter of the firm's century. Lord Moulton writes a preface, Mr. Leicester Sydney recounts the history of the house, Mr. Thomas Hannan tells of the early history of technology in Glasgow where Griffin's was founded, Professor Gowland writes on the development of metallurgical literature, Professor Henry Louis writes similarly on mining books, while other experts give records of Griffin's services in spreading knowledge in connection with engineering, shipbuilding, medical science, and chemical and industrial technology. A perusal of these appreciative essays confirms the impression prevalent among mining men as to the debt they owe to Griffin's, and proves the profound influence exercised by the firm in creating a reliable technological literature.

The firm was founded by Joseph Griffin, a merchant in Glasgow, one of his specialties being books and scientific instruments. The details of the early history are obscure, but it is known that he was in a large way of business in Nile Street in 1795. In those days Glasgow was, as now, a centre of engineering and technical developments, and Joseph Griffin was intimately associated with the leaders at colleges where science was taught. Thus the firm obtained and held for many years the position of publishers to the University. It is not quite clear when he began to publish on his own account. He had two sons, Richard and John Joseph, and it is possible that it was Richard who first undertook the publishing business, and not the father. The firm's name appears as Richard Griffin & Co., publishers, in the Glasgow Directory for 1820, and the earliest imprint still extant is dated the same year. For the purposes of record it is convenient to say that Griffin's, as a firm of publishers, started in 1820, and that it was then known as Richard Griffin & Co. Richard died comparatively young in 1832, and John, who had previously devoted much of his time to the study of chemical science, had to take control. He was an eminent chemist, and had studied in both France and Germany. He had translated German chemical works, and had written books on the blowpipe and other methods of chemical analysis. It is interesting to note, also, that he was one of the founders of the Chemical Society in 1841. In the year 1848 the business was removed from Glasgow to London. Richard Griffin had left a boy, Charles, who was twelve years old at the time of his father's death. When Charles became old enough, in 1852, the business of the firm was divided, John taking the instrument and apparatus portion and founding J. J. Griffin & Co., a firm still well known in this line, while Charles took the book business and established Charles Griffin & Co. Charles died in 1862, being short-lived like his father, and for some years his widow, aided by trustees, conducted the business. As they grew up, four of his children came to the assistance of their mother—Richard, Henry, Charles J., and Elizabeth. Of these, the last named was the genius of the family, and for some years Miss Griffin was head of the business and a notable member of the literary world. Unfortunately she died in 1899. Five years before this, her brothers Richard and Henry had died, while Charles J. died in 1907.

The deaths of Richard and Henry had caused Miss Griffin much anxiety, and she decided that assistance in the direction of affairs should be sought outside the family. She accordingly appointed Mr. Francis J. Blight as managing director. On Miss Griffin's death, Mr. Blight became chairman of the company as well as managing director, and ever since then the success of the firm has been due, almost entirely, to his quiet and untiring efforts, his wide knowledge, and his suave personality. Mr. Blight's career has been an interesting one. In his youth he disclosed unusual powers as an artist and draughtsman, and his earliest appointment was as assistant to the architect of the Great Northern Railway. He subsequently obtained an appointment in the survey department of the Land Office. Later he turned his attention to literary, antiquarian, and scientific pursuits, and we find him associated with the publishing firm of J. & A. Churchill, for whom he managed the *Pharmaceutical Journal* and the *Medical Times*. He is a noted microscopical artist, and he is in demand as a lecturer on literary and scientific subjects. These few details of Mr. Blight's record afford some indication of the fact that he, like John, Charles, and Miss Griffin, is a competent judge of the subject-matter which forms the basis of a publisher's business.

For some years Mr. Blight had as co-directors his son Horace, and Charles R., the son of Charles J. Griffin. Both of these met the call of duty and went to the war, and it is sad to relate that Horace Blight was killed. Arthur Downer, son-in-law of the chairman, has more recently joined the board. As for the future, there is a young Horace Blight, a young Charles R. Griffin, and another son of Charles R., named John Oswald. That the house of Griffin may continue to flourish is the sincere hope of its friend and admirer, the Editor of THE MINING MAGAZINE.

REVIEW OF MINING

Introduction.— Politically things are none too bright, though the danger to Poland from the Bolshevists has been removed. Unfortunately the refusal of the British Government to back Europe against the Bolshevists is causing much irritation abroad. The Irish question is still with us. The threat of coal-miners' and engineers' strikes is dislocating all arrangements for future activities in various industries. The bill for the creation of a Ministry of Mines has been passed, though in modified form, and the Ministry is to be only a department of the Board of Trade. Mr. W. C. Bridgeman has been appointed to be the first Secretary, as was expected. In the metal markets the movements have been devoid of any great amount of interest.

Transvaal.—The strike of enginemen and stokers on the Rand in connection with Sunday labour came to an end late in August, after the men had struck work for the four Sundays of the month. That they were actuated by no malignant intent was shown by the fact that they did not absent themselves from mines liable to damage or hindrance arising from a stoppage of the pumps. The men's claim was that they should be paid at the rate of time-and-a-half for Sunday work. This demand the Transvaal Chamber of Mines refused to grant, as it was quite contrary to the standing agreement. The matter is to be settled by negotiation, and a reasonable agreement is expected.

The Union Government has decided not to confiscate private German property in South Africa. Such property has of course been sold some time ago, and the funds thus received are in the hands of the Union Government, the total amount being over £10,000,000. Out of this, about half a million is to be appropriated to the payment of German debts in South Africa, and a similar amount is reserved for paying for property in Germany belonging to South Africans. The remaining nine millions will be treated as a 30-year loan, and interest is to be paid at 4%. The certificates will be untransferable for five years. This policy of postponement of payment and transfer has been adopted in order that the funds shall not get into undesirable hands. As regards concessions, they will be untouched, provided the titles are proved to be good.

Last year operations ceased at the Ginsberg mine, owing to exhaustion of the ore. It is now announced that the company is to go into liquidation, and a meeting to sanction this course will be held on October 29. Probably the realization of assets will provide a substantial dividend, amounting to as much as 3s. per £1 share.

Milling at the Heriot is to be continued during the dismantling of the plant, and thus the cost of pumping and hoisting during dismantling will be reduced. The directors say that they had several offers to work the property on tribute, but the terms were not good enough, so there was no alternative but to close down. There is a considerable amount of ore in reef packs and on the surface that can be treated to profit under the conditions named.

The development of vanadium ore at Doornhoek, 17 miles south-east of Zeerust, in the Transvaal, is to be undertaken systematically, and a company called the African Vanadium & Lead Co. has been formed for the purpose. The property was originally worked for lead, and hand-picked galena was shipped for some time. The examination of the dumps of low-grade ore with a view to concentration revealed the presence of vanadinite and pyromorphite. The property and the district generally have been examined by Drs. Wagner and Murchand for the Geological Survey, and Dr. Merensky has made an examination and report for the company. The amount of vanadium ore developed is estimated at 10,000 tons averaging 4% V_2O_5. By concentration a product averaging as high as 16% has been obtained (vanadinite contains 19·4% V_2O_5), which is saleable in America at £75 per ton.

The Mines Department has issued the following amended regulation as to rock-drills: "No person shall in the drilling of holes use or cause or permit to be used any machine drill in which only air is passed into the hole through the hollow jumper of the drill." This regulation is to come into force after March 31, 1921. The Department evidently holds that external water-spray is not sufficiently effective in settling the dust caused by dry flush. We have been informed that the Government authorities desire to go further and say something about the effects obtained by the combined air and water flush, for dust often escapes under such conditions; this may come later.

Diamonds.—The De Beers and other diamond companies are founding a Diamond Fields Mining Institute, its object being to provide lectures on practical, scientific, and technical subjects of interest to the general public. Arrangements have already been made for lectures on safety, rock-drills, air-compressors, pumping, timbering, explosives, and ventilation.

The Consolidated Diamond Mines of South-West Africa, the new company working the ex-German properties in South-West Africa, reports an output from January to June of 281,365 carats, obtained at an average cost of 18s. to 20s. per carat. The base price per carat has increased from £5. 12s. 4d. in January to £8. 4s. 4d. on July 1. In comparing the figures for cost and sale price, it must be remembered that the Government takes about 66% of the profit. Owing to the present fall in the demand for diamonds, the company's stock is gradually increasing.

Rhodesia.—The official figures for the monthly gold output continue to be issued in varying units, the premium never relating to each month's figures but being given in irregular lump accumulations. The July returns were £359,283, of which £155,921 was premium; the output in ounces is given at 46,208, so that the price per ounce less premium works out at 88s., a result which does not make for clearness. The returns from each individual mine also vary in a most confusing way, owing to the different prices received on the individual shipments.

At Lonely Reef the lode has been cut at the 22nd level, where it is found to be of satisfactory grade. The ore is reported to be oxidized, which is quite an unusual feature at such depths, and more information as to the method of occurrence is awaited. The shaft is down to the 24th level, and a cross-cut has been started. The future policy with regard to development in depth is under consideration.

West Africa.—The Ashanti Goldfields has been troubled with a strike at the metallurgical plant, which lasted for sixteen days, but the position has considerably improved since then. The July output at the Taquah mine was lower than normal owing to a strike and scarcity of labour. At the Abosso mine the mill was closed during the first half of the month in consequence of scarcity of fuel and labour troubles.

Nigeria.—Last month we mentioned that the Tin Areas of Nigeria was in financial difficulties, and was proposing to issue £300,000 convertible debentures. Since then the directors' report for the year ended May 31, 1919, has been issued, and meetings of shareholders have been held. The chairman, Mr. H. T. Miller, attributed the unfavourable position of the company to the difficulty of obtaining transport of merchandise on the local railways. Certain shareholders, who had raised objections to the directors' policy, have been appointed to the board, so that their opposition has been removed. On the other hand, many shareholders have called for a disclosure of the name of the people who are ready to take the debentures and assume control. Naturally the common supposition is that Levers are making the bed.

Australasia.—Our Melbourne correspondent writes in gloomy vein as to the possibilities of a settlement of the labour troubles at Broken Hill. On the other hand, cable reports published on this side are more optimistic, and there is a distinct hope that the decision of Mr. Justice Edmunds will lead to a satisfactory conclusion.

The report of the Broken Hill Proprietary for the year ended May 31 last covers a dead period at the lead mines, and interest centres on the iron and steel business of the company. Here again labour difficulties greatly hindered progress, and in particular the shipping strike made it necessary to shut down the blast-furnaces for a time. The production of galvanized iron has been started in association with John Lysaght, Ltd., and negotiations for the manufacture of tinplate are well advanced. A third blast-furnace is being built. In order to remove the worries caused by shortage of shipping, the company has bought two steamers for its coastwise traffic between the mines, iron-works, and coke plants.

The Great Cobar copper mine has been finally closed by the receiver for the debenture-holders in England, owing to the increase in costs all round. Thus comes an end to a mine which did well for its original Australian owners, but caused a multitude of worries all round, to both promoters and the public, when introduced here.

The Roebourne Copper Mines, Ltd., is a company the chief operations of which are connected with share-pushing of an unpleasant type. The property is near Whim Well, in northern West Australia, but to what extent it has been worked is not clear. Anyway shipments are not being made. The latest yearly report mentions the acquirement of a silver-lead property in the same neighbourhood, and states that 290 tons of ore averaging 34% of lead and 11½ oz. of silver per ton had been shipped. Last year it was announced that an interest had been acquired in the Marievale Nigel Gold Mines & Estates, Ltd. The latter company can hardly expect to reap much glory from its association with Roebourne.

India.—The Cape Copper Company announces that its mines at Rakha Hills are not yet on a paying basis, and more capital is to be raised by an issue of debentures.

Burma.—Last month we mentioned that Mr. R. Tilden Smith had given notice of opposition to the winding up of the English Burma Corporation and the transfer of the property to a company of the same name registered in Burma. This opposition has since been withdrawn, so that no poll was taken. Thus no public record has been made of the exact number of shares he owns or influences. It is understood, however, that his interest, though not sufficient to give him the control of the company, is big enough to block any move that requires a three-quarters majority, such as the transfer of the assets to another company.

The official figures for the exports of wolfram and cassiterite concentrates during 1919 from the Tavoy district of Burma are: wolfram 2,817 tons, and cassiterite 300 tons, as compared with 3,636 tons and 202 tons respectively in 1918. The council of the Tavoy Chamber of Mines points out, however, that these figures do not give the true position owing to the wolfram concentrates containing at least 21% of cassiterite. Thus the 1919 figures for wolfram should be reduced by 591 tons to 2,226 tons, and the cassiterite figures should be correspondingly increased to 891 tons. Presumably the cassiterite is a clean concentrate. By this rearrangement of figures the relative importance of wolfram and cassiterite in Tavoy is seen in an entirely new light. The true position would be given if the Government's returns for exports contained particulars of the assays of the parcels of concentrates. During the first half of 1920 the exports are reported officially at 1,173 tons of wolfram concentrate and 31 tons of cassiterite, but much of the output is being stored pending sales or more favourable terms.

Malaya.—Last month we mentioned that the independent expert sent from Australia to investigate the Badak tin property in Kedah had reported a total failure to confirm the boring results quoted by the promoter, and that the latter had taken up the challenge and offered to visit the property again. News has since come to hand that he has had his passport withdrawn by the Commonwealth authorities, which means that they are making inquiries into the whole business and desire that he should not leave the country in the meantime.

The Chenderiang company reports that during the year ended March 31 the dredge treated 930,000 cu. yd., and extracted 286½ tons of tin concentrate, the yield per yard being 0·69 lb. In the hydraulic elevating section 87 tons was recovered, making the total 373½ tons, which realized £62,304. The profit, after allowance for depreciation of plant and income tax, was £12,720, out of which £3,387 has been written off development account and £9,250 has been distributed as dividend, being at the rate of 10%, tax paid. The company thus recovers from the depression felt on the publication of the report a year ago, when the yield per yard was only 0·44 lb. and no divisable profit was earned.

The report of the Kramat Pulai company, which works alluvial tin and scheelite deposits in the Kinta district, shows that during 1919 the yield of tin concentrate was 124¾ tons and of scheelite 101¼ tons, realizing respectively £140. 15s. and £189. 19s. 6d. per ton. The winning of scheelite was discontinued after April, 1919, owing to its being unmarketable. The scheelite occurs in a separate alluvial bed from the main tin deposits, but tin is also found in the overburden above the scheelite deposit. This overburden is now being removed and the tin recovered. Eventually conditions will arise that will make it possible to work the scheelite once more. The company's profit during the year was £19,139, of which £15,000 has been distributed as dividend, being at the rate of 15%.

Cornwall.—The directors of Calloose Tin Mines & Alluvials, Ltd., have issued a circular admitting the "initial mistakes," and announcing that a new scheme is to be placed before shareholders shortly. They also say they are taking legal advice as to what steps, if any, can be taken against the vendor. Since the issue of the circular it has been announced that a writ has been served on Mr. A. F. Calvert, who through one of his syndicates was the vendor to the company.

Wales. — The nature of the directors' report of the Aber-Llyn company and the chairman's speech at the shareholders' meeting indicate that it is time the entire responsibility was placed in the hands of a mining engineer. There are troubles with regard to development and concentration that can only be solved by an untrammelled expert, and the directors would do well to modify their policy accordingly. Otherwise it is difficult to see how a low-grade zinc-lead mine can be made to pay nowadays.

Canada.—The Mining Corporation of Canada is being sued by the La Rose Consolidated of Cobalt for compensation in connection with the re-treatment of old tailing reclaimed from the bed of Cobalt lake. In the earlier days the tailings from the various mills were dumped into the lake and no effort was made to segregate the proprietary rights. The question is whether things that are thrown away are still the property of the original owner; if it is held that they are, there should not be much difficulty in approximately calculating the respective amounts from the records of operations.

United States.—The Geological Survey gives the output of lead during 1919 as 496,094 tons, of which 208,751 tons was desilverized lead, 147,744 tons soft lead, 67,938 tons desilverized soft lead, 13,874 tons antimonial lead, and 57,787 tons foreign desilverized lead. The total figures in 1918 were 658,765 tons, and in 1917, 629,415 tons.

The Camp Bird company reports that development on the vein in the east heading from the tunnel has been suspended for the present as the ore disclosed is too patchy for profitable mining. Work has instead been transferred again to the west drive. Here 614 ft. of driving has been done, but no ore at all has been found so far, so that the prospects are none too bright.

American Oil.—A company has been formed called the British Equatorial Oil Co., Ltd., with a capital of £200,000. Mr. F. W. Baker is the chairman, and the National Mining Corporation, the Mexican Corporation, the D'Arcy Exploration Co., and the Scottish American company are signatories to the memorandum of association. It is understood that the business in prospect is in America, but details as to the position of the properties are not available for publication.

Mexico.—A new discovery of ore of considerable promise has been made in the Esperanza mine at El Oro. It will be remembered that the known ore-bodies were approaching exhaustion and that there has not appeared to be much chance of finding further supplies. It was announced a few months ago that development was being continued in order to search for the faulted portion of the Descubridora lode, and that for this purpose a crosscut was being driven from the 8th level. The discovery has, however, been made on the 5th level. The lode is here 4 ft. wide, and averages 14 dwt. gold and 38 oz. silver per ton. Further developments will be watched with unusual interest.

The latest news with regard to the political position in Mexico is that Obregon has been elected president. It has been said that his fair hair and blue eyes proclaim him as a descendant from Irish stock, and that his original patronymic was O'Brien. May he have luck in governing his country!

Bolivia.—The Guggenheims have asked for an extension of their options on the Potosi tin properties in order to continue the examination. The firm is proceeding with work at Caracoles, and is building a road to connect with the railway. This property is said by credible parties to be bigger than Llallagua or Uncia, which means that it has the promise of becoming the biggest tin mine in the world.

Owing to new laws recently passed, Aramayo Francke Mines, Ltd., now ends its year on December 31, so that the report issued this month covers 19 months, from June 1, 1918, to December 31, 1919. During this period the profit was £667,121, as compared with £274,148 during the 12 months ended May 31, 1918. Out of the profit £179,127 has been distributed in dividends, being at the rate of 30%. Owing to pending litigation relating to income tax and also to provide for new plant and additional development, the remainder of the profit is kept in hand. The report does not contain details of output and sales of tin and wolfram concentrates and other products; these figures are usually given by the chairman at the shareholders' meeting.

Colombia.—The Colombian Mining & Exploration Co. has issued a brief report on its property by Mr. Frank B. Powell. He states that at the Marmato mine the ore reserve amounts to 509,080 tons, averaging 40s. 10d. per ton, while the "anchadura," that is, old stope-filling, is estimated at 314,400 tons, averaging 24s. He says the gold is associated with marcasite, which can be separated from the gangue by concentration. His recommendation is that the concentrate should be treated by roasting, grinding in pans with cyanide, passing over plates, and agitation. The plant that is being sent out provides only for cyaniding, but Mr. Powell says the recovery is only 80%, and that the cost of cyanide is 8s. per ton of concentrate, hence his proposal that roasting-furnaces and pans should be added. Probably, however, both Mr. Powell and the manager are wrong in their metallurgy, for the ore is far more complex and troublesome than they suppose or admit.

Roumania.—The control of the oil property of the German-owned company known as the Steaua Romana Oil Co. has been acquired by Roumanian, French, and British interests. The shares in the company are being purchased as to 50·1% to the Roumanian Government and as to 24·95% each to French and British groups. The English shares will be held by an English company to be called the British Steaua Romana, Ltd., the chief shareholders of which will be the Anglo-Persian Oil Co., Stern Brothers, and James Dunning & Co.

THE PORCUPINE GOLDFIELD, ONTARIO.

By DR. J. MACKINTOSH BELL.

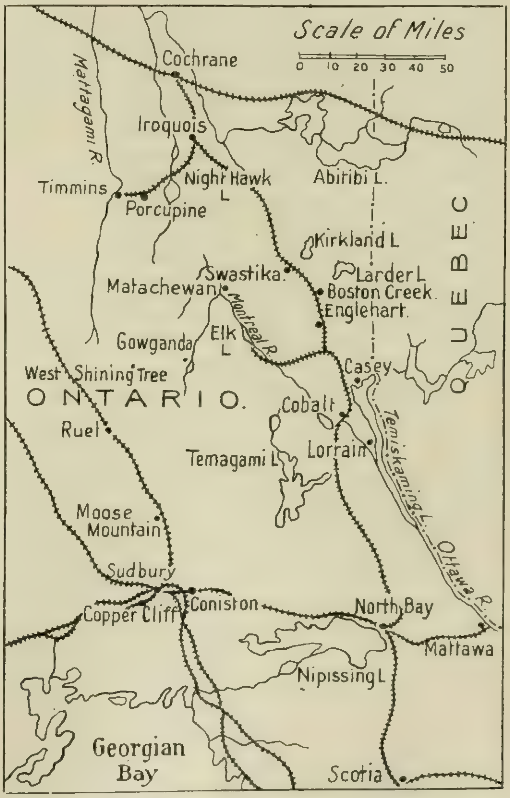
We reproduce herewith a Second Lecture delivered by the Author at Harvard University.

INTRODUCTION.—Prior to the discovery of the Porcupine goldfields, gold-bearing quartz veins had been known for many years in Ontario, but the ultimate failure of the few mines that were developed in various places and succeeded only for a time, shook public confidence in the probability of deposits of any great importance being found in the province. It was for this reason that public interest was not attracted to the Porcupine district in the early days of its history. In the summer of 1909, however, a prospector named J. S. Wilson made the spectacular discovery known as the "Golden Stairway" on what is now the Dome property, and immediately a rush to the district began. In a few weeks the country for many miles around was staked, and numerous promising outcrops had been discovered. Fortunately, the most promising discoveries came under the control of strong financial interests, some of whom had already prospered at Cobalt, so that the district had a fair chance from the very first.

By the beginning of 1911 the construction of several mills was well advanced. Unfortunately the district then received a temporary setback by forest fires, which swept away the new plants, destroyed the settlements, and caused the loss of many lives. The recovery from this catastrophe was rapid. By 1912 four mills had been erected—on the Dome, Hollinger, McIntyre, and Vipond—and two more on the Dome Lake and Porcupine Crown were under way. In November, 1912, the Hollinger paid its first dividend of 3% on its capital stock, a total representing a distribution of $90,000. Since that date the progress of Porcupine has been for the most part steady and unbroken, though developments on all, save the well-established and higher-grade mines, has been impeded of late by the rise in the price of labour and of materials used in the mining and metallurgical treatment of the ore.

To-day Porcupine is probably the most promising gold district in the world, and the Hollinger, after only ten years of development, ranks as one of the two or three greatest gold-mines of the world in point of output, while in regard to prospects it has perhaps no equal. The transportation facilities to the district are excellent, a branch railway from the main line of the Temiskaming and Northern Ontario having been completed in 1911.

TOPOGRAPHY.—The portion of the Porcupine goldfield at present productive is limited to the township of Tisdale, an area six miles square. There are a number of promising prospects outside of the township, but as yet none has assumed any importance. The area is one of low local relief. Rock exposures are



MAP OF PART OF ONTARIO SHOWING POSITION OF PORCUPINE.

common, but these are in general in the form of low ridges or hummocky mounds rather than of prominent elevations. Broad expanses of sand plain and a number of lakes and streams diversify the physical character of the country. The Metagami River—a large stream flowing to Hudson's Bay—flows northerly a few miles west of the Hollinger. The area was originally covered with dense forest, mainly spruce, poplar, and birch, but has been greatly depleted by the fires which have swept the country since the opening of the camp.

The three principal settlements are South Porcupine, Schumacher, and Timmins, the last-named a well-built town of about 6,000 people. The working mines occur within Tisdale township in three more or less definite positions, the Pearl Lake group, the Dome group, and the Davidson group. The Pearl Lake group, in the vicinity of the lake of the same name, contains the Hollinger Consolidated, the Porcupine Crown, the Porcupine V.N.T., the McIntyre, Schumacher, Jupiter, and Plenaurum (the last two under option to the McIntyre), and other properties. The Dome group contains the Dome, the Dome Lake, the Dome Extension, and a number of other claims. It lies about four miles east-south-east of the Pearl Lake group. The Davidson group, containing the Davidson, North Davidson and other properties, is situated about five miles east-north-east from the central part of the Pearl Lake group on the same line of strike as the rocks enclosing the Pearl Lake ore-bodies.

GENERAL GEOLOGY.—The accepted geological sequence of the compact rocks of the district is as follows:

KEWEENAWAN	Quartz - diabase, olivine-diabase.
ALGOMAN	Granite - porphyry, felspar-porphyry.
PRE-ALGOMAN	Lamprophyre, serpentine, and quartz-porphyry.
TEMISKAMING	A series of conglomerate, slate, greywacke, and carbonate rocks, all of which are more or less schistose.
KEEWATIN ...	A complex of basic to acid volcanics, diabase, serpentine iron formation and carbonate rocks. These rocks are largely altered to schists.

In connection with the ore deposits interest centres in (*a*) the quartz-porphyry of the Pre-Algoman, (*b*) the schistose conglomerates, slates, and greywackes of the Temiskaming, and (*c*) the schistose volcanics of the Keewatin.

The quartz-porphyry is generally a whitish or greyish rock, coarse in grain and commonly containing visible phenocrysts of quartz and altered felspar. It is prominently developed in the vicinity of the Pearl Lake and Dome group of mines, where it is highly schistose. Elsewhere it is more massive. In form it occurs in places as more or less definite dykes, but, especially in the vicinity of the mines, it generally appears oftener as masses of irregular shape.

The conglomerates, slates, and greywackes of the Temiskaming definitely show in places their sedimentary origin, though in the vicinity of the Dome group of mines, where in places they are intimately related to the ore deposits, they are highly schistose. The conglomerates on the surface show the included pebbles, but belowground the fresh rock breaks without any relation thereto, and it is difficult to distinguish any variation from inclusion to matrix.

It is probable that the Keewatin igneous rocks represent a series of flows of considerable chemical range, associated with equivalent volcanic fragmentals and intrusive rocks, but it is extremely difficult, so much have the rocks of this nature in the Porcupine field been altered, to recognize definite features. Rocks which seem to be as acid as dacite and as basic as basalt have been recognized. Old diabases have been noted, while serpentine rocks seem to suggest an origin even more basic.

Pillow-lava structure is developed in many places, amygdules are of common occurrence, while agglomeratic features are less commonly seen. What appear to be intrusive contacts between flows and an intruding rock are also found. Intrusive contacts between the quartz-porphyry of the Pre-Algoman and the schists and Temiskaming rocks occur in many places. While the rocks of this series are everywhere more or less schistose, the schistosity is intense in many places, notably in the vicinity of the mine groups. As may be expected in rocks which have been subjected to such compressive forces, faulting is of widespread occurrence, but this in large part antedated the deposition of the ore deposits, so that ordinarily they do not seem to have been displaced excepting for short distances.

For practical purposes the rocks in association with the Porcupine ore deposits are described as quartz-porphyries, conglomerates, slates, and schists.

NATURE OF THE DEPOSITS.—One of the noteworthy features in connection with the mineral deposits of Porcupine is the occurrence of the most extensive ore-bodies in the most intensely schisted areas. The deposits in relatively unschisted rocks are unimportant. The close association of the deposits in the Pearl Lake group and Dome group with the quartz-porphyry would seem to be significant.

Though there are many different types of auriferous quartz deposit at Porcupine, there is a gradation between them all, and nearly every property shows examples of each type. Consequently, it is impossible to attempt any classification of the occurrences based on structural lines. The form of the deposit naturally depends largely on the nature of the enclosing rock whether highly schistose or more or less massive.

The most characteristic type of deposit is the quartz lens of irregular shape, without much definition either in vertical or horizontal dimensions. These may be only a few feet long and wide, or hundreds of feet long and even thirty or forty feet in width. Ordinarily, one lens does not occur singly but in chain form connected like a string of sausages. One lens may slightly overlap another, or several lenses may be in line separated by schist which may be so highly mineralized as to be classed as ore or practically barren.

Irregular stringers, subsidiary lenses, or even well-defined quartz veins standing at every angle as compared with the main deposit ramify into the wall-rock from the lenses. In places the deposits consist mainly or almost entirely of highly mineralized schist in which important or well-defined masses of quartz are relatively speaking negligible. The well defined quartz vein with clear-cut walls occurring independent of the usual mass of irregular shape is rare. The narrow rich vein on the Preston East Dome is of this type.

In many of the deposits, the filling consists largely of altered country-rock, containing much carbonate of varying composition, sericite, chlorite, pyrite, and fine quartz. This altered country forms inclusions of all sizes and shapes within the fairly coarsely crystalline white quartz, or as already mentioned, forms practically the entire deposit. Pyrite is not ordinarily so common in the actual quartz as in the included country. Chalcopyrite, zinc blende, pyrrhotite, arsenopyrite, galena, and scheelite all occur in some of the deposits, while tourmaline is also found.

The gold is very irregularly distributed in the deposits; generally it occurs in the inclusions of altered country, again associated with fine dark streaks in the white quartz. Under the microscope it is generally found in areas which have been crushed or in the quartz or schist adjoining these crushed areas. The gold is frequently visible and in places is very coarse. In the Golden Stairway at the Dome streaks of gold had a width of $\frac{1}{4}$ in.

The walls of the deposits are commonly very indefinite, the deposit material being frozen on to the enclosing country rock. The walls seen in a number of places would seem to indicate a secondary movement in the quartz as they are well slickensided. The enclosing rocks are invariably much altered, silicified, carbonatized, and pyritized; the deposits are apparently richer and bigger where the alteration is greatest. While the deposits containing the richest ore-shoots generally occur within the schists in close proximity to the quartz-porphyries, those actually within the latter seem generally to carry only small erratic shoots. Veins which pass from the schists entirely within the porphyries soon lose their value.

Assay plans show the grade of the deposit-material to vary immensely within very short distances both vertically and horizontally. The ore-shoots consequently are often poorly defined. Even in the Hollinger continuous ore does not generally extend more than 200 or 300 ft., but one shoot may be separated from another by only a few feet of barren or low-grade material. On the 200 ft. level the ore-shoot on No. 1 vein of the Hollinger was proved for over 1,000 ft. in length.

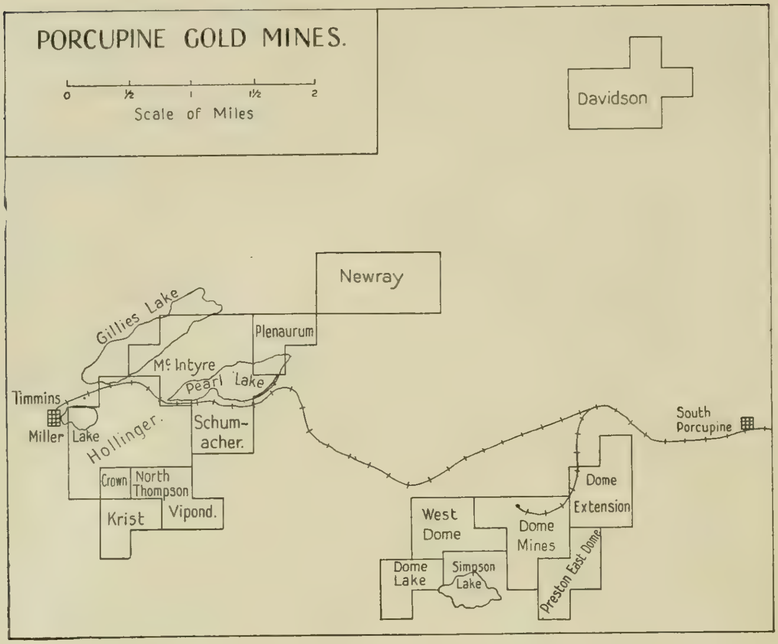
To the deepest workings yet attained, 1,350 ft. in the Hollinger and 1,500 ft. in the McIntyre, there is no evidence of depreciation in the value of the ore. In the Pearl Lake group of mines the grade of ore averages around \$10·00; a little higher in some of the mines and lower in others. In the Dome it is generally lower.

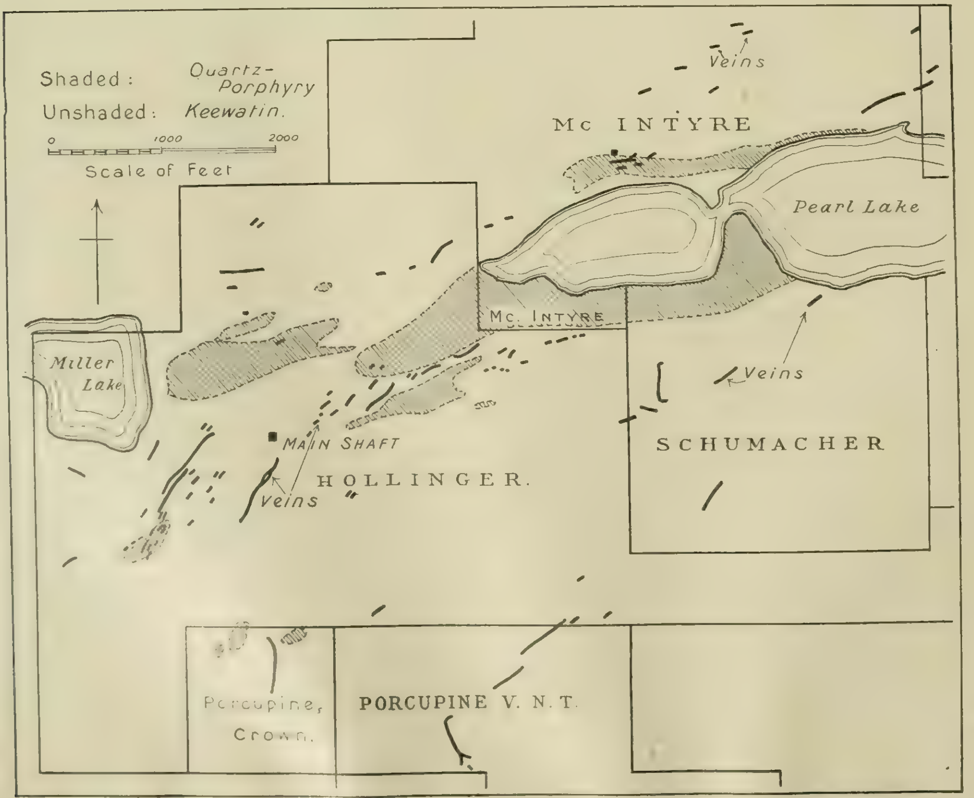
The ore is extremely rich in patches in all of the working mines. The Crown Porcupine vein carried ore of about \$30·00 grade over a stoping width for a length of over 400 ft., and to a depth of between 400 and 500 ft. This was probably the richest shoot in the camp.

From a metallurgical-treatment standpoint Mr. Noel Cunningham, who conducted extensive experiments at the Hollinger, divides the Porcupine ore into two classes. Class (A) ore is a pure quartz with inclusions of schist. Generally, it is heavily fractured and breaks down readily to sharp hard grains about *minus* 10 *plus* 20 mesh requiring further comminution to release the gold. It carries very little pyrite. The gold is entirely free and apt to be coarse, but very often spongy, going into solution readily on that account. The gold is 60% to 85% free-milling, depending on the grade of the ore. Class (B) ore is an iron silicate schist strongly laminated, carrying 4% to 5% pyrite. The ore breaks down readily in milling and makes a comparatively large amount of non-crystalline slime; owing to its high specific gravity it is quick settling. In Mr. Cunningham's opinion the gold in Class (B) is free but so finely divided that it will neither run nor amalgamate.*

In length a single deposit is generally short,

* Bulletin of the American Institute of Mining Engineers, March 1915.





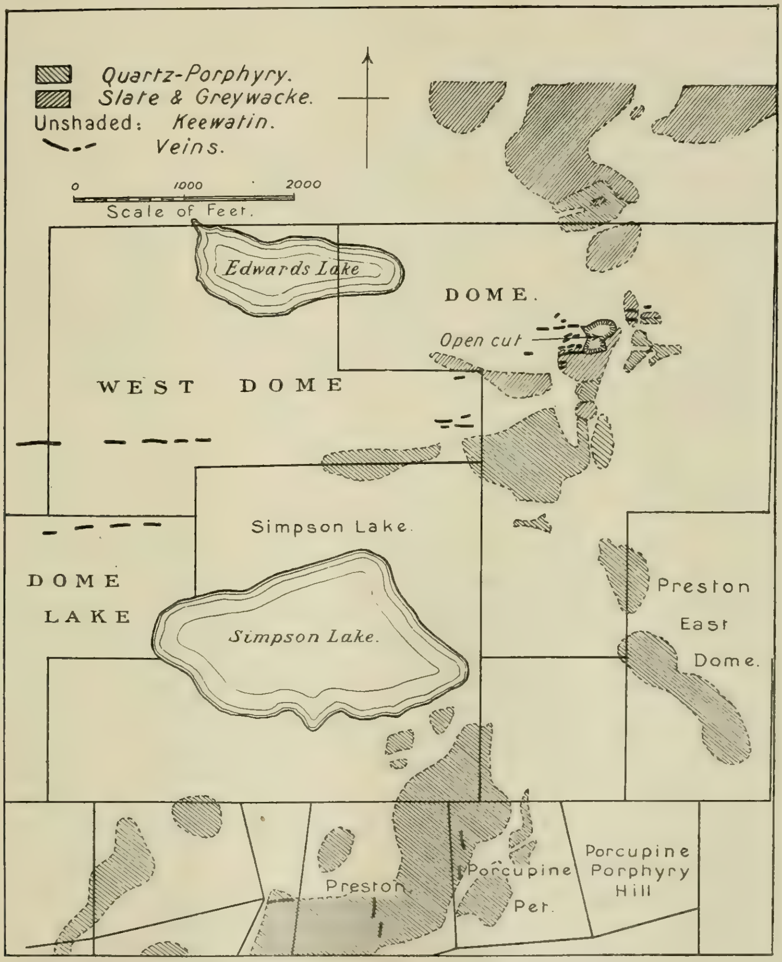
PEARL LAKE AREA, PORCUPINE.

but a linear chain of quartz lenses overlapping or separated by short distances of schist may have relatively great longitudinal extension. Thus, the Hollinger shows among its many ore-bodies a closely connected chain of lenses which is virtually a continuous deposit about 2,500 ft. long.

The strike of the deposits usually agrees with that of the enclosing schists, especially where the schistosity is intense, but in places there is not this concordance. On the Porcupine V.N.T., for example, a portion of the main vein system is a series of lenses parallel with the schistosity, and a portion follows a definite fault fissure at right angles to that structure. The general strike of the veins is east-north-east.

The dip of the deposits varies from horizontal to vertical, and ordinarily cuts the cleavage of the enclosing schists.

ORIGIN OF THE DEPOSITS.—The geologists of the Ontario Bureau of Mines consider that the mineral deposits of Porcupine have probably a genetic connection with the intrusion of the Algoman granitoid rocks occurring in relatively close proximity, and that the quartz and the various other minerals in the deposits represent the residual differentiate of that intrusion. In support of this theory a number of hypotheses are presented: the irregular occurrence of quartz in many of the deposits in lenticular masses resembling pegmatite dykes; the occurrence of felspar, tourmaline, and scheelite in several deposits; the great pressure at which quartz has been deposited indicated by the presence of liquid inclusions, and gas bubbles, as frequently is the case in the quartz of granite.*



DOME AREA, PORCUPINE.

* See "The Porcupine Gold Area," by A. G. Burrows.

While the solutions which permeated the schists (and the associated quartz-porphyry) where they were intensely sheared, or ascended fissures in the more massive varieties filling the cavities and metasomatically replacing the country rocks with sericite, pyrite, carbonate, and quartz, may have mainly accompanied the Algoman intrusions, it seems possible that the initial mineralization may have immediately followed the intrusion of the Pre-Algoman quartz-porphyries. These rocks in the Dome section and in the Pearl Lake section occur in intimate association with the ore-bodies, and apparently have marked influence on their richness and extension.

THE PRINCIPAL MINES.—The Hollinger is the most important mine in the district. Its large acreage occupies the central and richest part of the goldfield. Its known ore-reserves, amounting at the end of 1918 to 4,275,570 tons of a value of $38,975,530, or an average grade of rather more than $9·00 per ton, represent explorations mainly above the 800 ft. level in a limited part of the property and entirely above 1,350 ft. At this depth there appears to be no marked evidence of depreciation in the size or value of the ore-bodies. The future of the property would thus appear to be particularly bright.

The rocks at the Hollinger, as in the whole of the Pearl Lake section, consist of altered and highly schistose quartz-porphyries and of schists which show almost every degree of such alteration as comes under the head of silicification, carbonatization, and pyritization. Within a length of about 3,000 ft. by over 1,000 ft. numerous ore-bodies are being developed which show a general parallelism to each other and to the enclosing schists. The property is excellently equipped with thoroughly modern buildings and plant. There are several shafts, but the ore is mainly raised through the central shaft. This has six compartments; two for hoisting ore; two for men and supplies; one for conducting development below the working level; and one for ladderways, pipes, and electric conductors. There are stations at the 425 ft. level, 800 ft. level and 1,250 ft. level. It is equipped with two powerful electric hoists which will permit of opening stations at lower levels with development downwards. Electric locomotives operating in the cross-cuts at the principal levels collect the ore dropped through an elaborate system of ore-passes from the intermediate levels and deliver it to the shaft.

There is nothing especially remarkable in the system of mining. The walls of the deposit stand well. The ordinary shrinkage system is followed, necessitating a minimum amount of timbering and, as yet, practically no filling. The levels are laid out at intervals of 150 ft.

Prospecting for new ore-bodies in the Hollinger, as in several other of the larger properties of the district, is conducted with great success by the drilling of horizontal holes from the main workings at right angles to the strike. Leyner machine drills are used in stoping.

TABLE 1.—HOLLINGER CONSOLIDATED GOLD MINES, LIMITED.

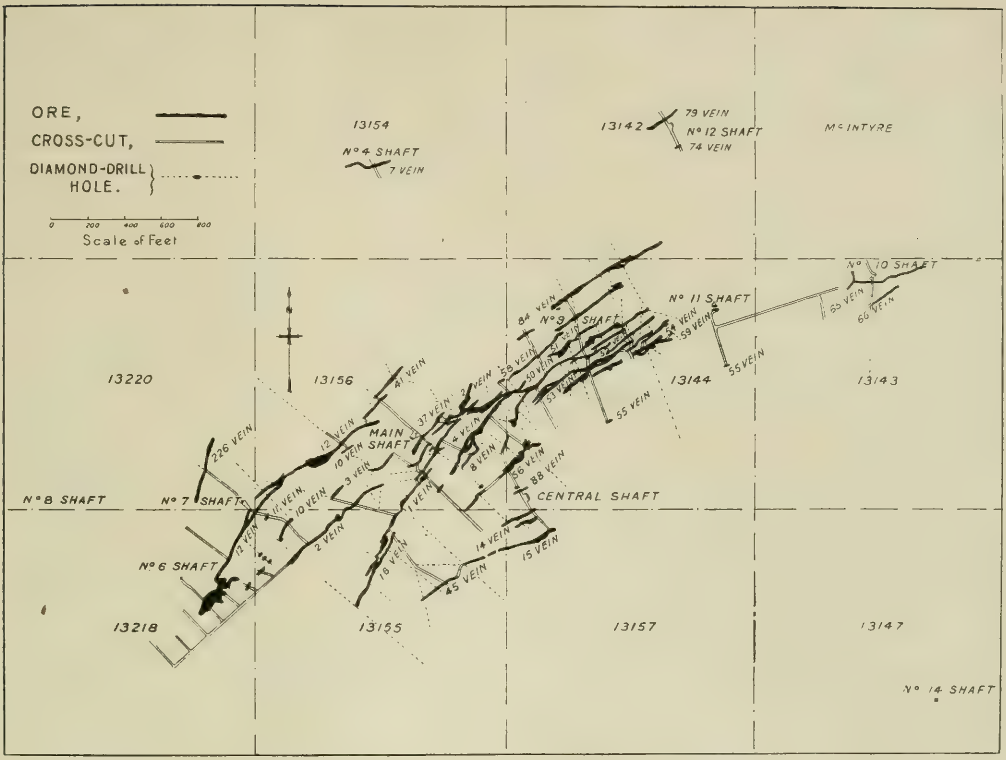
Year	Company	Total Income $	Net profits from operations $	Paid in dividends $
1912	Hollinger	924,571	371,801	270,000
1913	Hollinger	2,471,273	1,503,882	1,170,000
1913	Acme	22,698	—	—
1914	Hollinger	2,710,432	1,611,058	1,170,000
1914	Acme	53,698	—	—
1915	Hollinger	3,249,698	1,916,466	1,560,000
1915	Acme	1,036,087	560,577	160,000
1916	Hollinger Con.	5,285,862	2,676,409	3,126,000
1917	Hollinger Con.	4,271,260	1,720,314	738,000
1918	Hollinger Con.	5,908,327	2,588,563	1,230,000
	Totals	25,933,910	12,949,074	9,424,000

TABLE 2.—HOLLINGER CONSOLIDATED GOLD MINES, LTD.

SUMMARY OF ORE RESERVES.

Vein	Tons	Value Per Ton $	Estimated Gross Value Dec. 31, 1918 $	Estimated Gross Value Dec. 31, 1917 $	Remarks
1	288,250	11·00	3.170,630	3,381,170	
2 E. End	85,080	8·89	756,200	946,030	
2 W. End	109,800	6·02	660,410	734,280	
3	23,520	5·67	133,280	133,280	
5	23,190	10·41	241,340	325,120	
7	17,000	10·47	178,000	178.300	
9	16,410	11·68	191,680		Included with 26 Vein in 1917
10	27,600	7·76	214,400	214,400	
12	405,460	6·57	2,666,120	3,533,330	
13	37.000	5·54	205.000	205,000	
14	134,450	7·67	1,030 670	1,193,870	
15	86,200	8·22	708,720	813,940	
16	7,040	7·40	52,100	52,100	
26	54,540	6·93	377,900	343,200	
37	9,380	8·22	77,140	77,140	
44	8,000	20 00	160,000	160 000	
50	587,350	8·12	4,768,580	5,252,210	
51	31,180	7·71	240,190	279,900	
52	86,130	10·09	868,930	872,260	
53	470,430	7·38	3,472,070	4,411 510	
54	90,030	6·59	593,440	766,300	
55	181,440	11·32	2,053,360	624,680	
56	106,200	6·10	648,150	679,940	
58	328,030	10·23	3,355,920	4,374,740	
59	57,970	10·85	628,690	628,690	
63	55,020	4·00	220,300	220,300	
64	25,950	7·61	197,550	197,550	
65	135,240	10·51	1,421,940	1,421,940	
66	27,690	11·54	319,540		Included with 65 Vein in 1917
74	14,000	4·24	59,400	59,400	
79	17,730	5·52	97,800	97,800	
84	396,800	15·77	6.258,050	3,606,850	
85	300,140	7·82	2,348.460	1,667,350	
88	13,810	10·54	145,610	43,800	
200	4,450	15·20	67,630	61,950	
226	13,060	29,58	386,330	370,100	
Surface Veins	212,020	9 86	2,091,065	2,303,305	
Surface Dump	1,490	9·00	13,410	...	
	4,489,080	9·15	41,080,005	40,231,435	

Figures are for net ore measurements. No allowance has been made for dilution of ore with waste.

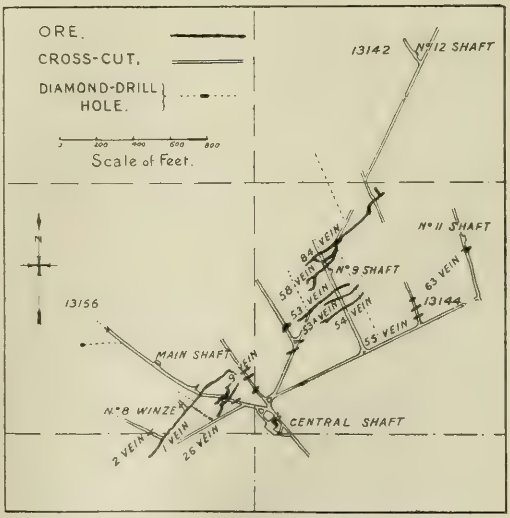


PLAN OF 200 FT. LEVEL, HOLLINGER CONSOLIDATED.

From the main shaft of the Hollinger the ore is elevated by a covered incline tramway to the mill bins after preliminary crushing in powerful crushers within the shaft. The mill capacity is 3,500 tons, though for various reasons, but chiefly on account of the labour shortage, this is not being fully utilized. The treatment varies somewhat in detail in the newer and older portions of the mill, but in general consists of (1) stamping and fine grinding in solution, (2) agitation, and (3) concentration. The concentrates from No. 3 are reground in solution, again washed, and agitated. Further details relating to the metallurgical practice at the Hollinger are outlined in a succeeding paragraph, giving the treatment for the field in general.

The figures in Table 1 show the gross income, net profits from operations, and dividends derived from the Hollinger property (formerly the Hollinger and Acme) up to the end of 1918.

The McIntyre adjoins the Hollinger on the north-east and owns not only the original McIntyre claim but the Pearl Lake; it has options over the Jupiter, Plenaurum, and Rea, and is, consequently, a very powerful concern. In the early days of its history when development was limited to the veins in the porphyry it was not very successful, but within the last few years following extensive exploration of the ore-bodies in the schists it has made rapid progress. The development in the porphyry was in the south-western corner of the Mc-



PLAN OF 800 FT. LEVEL, HOLLINGER CONSOLIDATED.

Intyre claim, while that in the schist is on the southern part of the Pearl Lake ground. Here near the surface the ground was broken, the values erratic, and the shoots short, but in depth (that is below 600 ft.) wide ore-bodies relatively constant in values have been obtained. At 1,125 ft. ore of an average grade of \$16·00 over an average width of 14 ft. is reported for a length of 750 ft. It must not be thought that the width in this distance is constant; the ore-body varies from a few feet to 60 ft., and the values exhibit the usual irregularities characteristic of the Porcupine district. It is noteworthy that the ore-body consists largely of mineralized schist containing comparatively little coarsely crystalline quartz.

The shaft has now reached a depth of 1,500 ft. The ore reserves are given in the last report (dated June 30, 1919) as 433,057 tons carrying \$4,777,324, or ore of an average grade of \$11·00 per ton. The methods of mining are similar to those pursued at the Hollinger. The mill practice is one of the simplest and most effective in Porcupine, and consists essentially of fine grinding in cyanide solution, agitation, and continuous decantation. The mill capacity is 550 tons daily. The figures in Table 3 show the number of tons milled, value per ton, gross value, and recovery, up to June 30, 1919.

TABLE 3.—McINTYRE PORCUPINE MINES, LIMITED.

Date	Period Months	Tons Milled	Value per ton	Gross Value	Yield per ton	Total Yield
			\$	\$	\$	\$
1912	12	14,500	7·00	101,555	5·25	76,166
1913	12	31,979	7·85	251,314	7·05	225,752
Jan. 1, 1914, to March 31, 1915	15	85,654	8·87	760,232	8·39	718,331
April 1, 1915, to March 31, 1916	12	105,758	7·71	815,345	7·38	779,990
April 1, 1916, to June 30, 1917..	15	195,307	10·00	1,954,793	9·55	1,864,914
July 1, 1917, to June 30, 1918..	12	178,327	10·05	1,793,197	9·61	1,714,258
July 1, 1918, to June 30, 1919	12	179,874	9·78	1,759,627	9·29	1,671,646
		791,399	9·40	7,436,065	8·90	7,051,059

Dividends amounting to \$1,638,127 (45% on the capital issued) were declared up to January 2, 1920.

There are at least three other properties of importance in the Pearl Lake section besides the Hollinger and McIntyre, namely, the Porcupine V. N. T., the Crown Porcupine, and the Schumacher. The Schumacher adjoins the Hollinger on the east, the Porcupine Crown and Porcupine V. N. T. on the south.

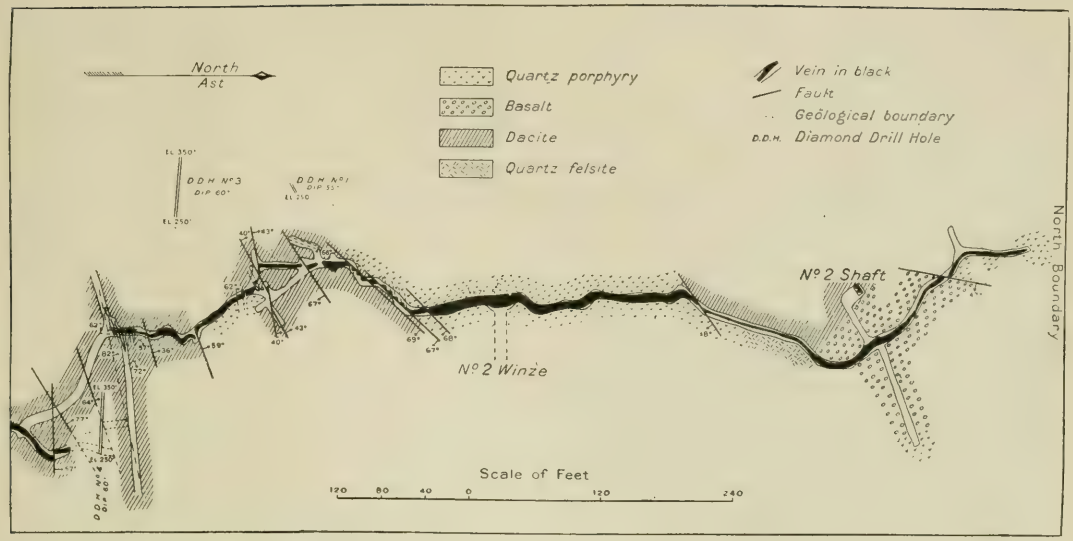
The Porcupine Crown was for a time an important producer and a dividend payer. Its operations were limited to a single vein of great richness, which in the upper levels was mainly in schist but partly in porphyry. The values became erratic and generally poor below 500 ft. where the deposit appears to be for the most part within quartz-porphyry. It has a well-equipped 20-stamp mill of a capacity of 130 tons, the process being stamping and fine grinding in solution, with plate amalgamation in closed-circuit with tube-mill and classifier and complete counter-current decantation.

The Porcupine V. N. T. is largely an undeveloped property. It was closed down during the latter part of the war on account of the scarcity of labour and high price of materials, and has not yet reopened. It has several large ore-bodies of good grade and a large area of unexplored ground occurring under excellent structural conditions. Development has reached a depth of 600 ft. The mill has a capacity of 120 tons, the process consisting of fine grinding in cyanide solution, agitation, and complete counter-current decantation.

The Schumacher is also closed at present. It has a mill capacity of 200 tons.

The Davidson is the only property which has been as yet at all developed in the Davidson section of the camp. The rocks associated are entirely schists, which are in places very highly foliated and altered with the development of the usual secondary minerals. Large lenses of quartz carrying in places very rich ore occur within these sheared zones. The present mill has a capacity of only 80 tons, but it is understood a larger plant is shortly to be erected.

The Dome, consisting of six claims, is in many ways the most interesting property in the district. Associated with the ore-bodies are Temiskaming conglomerates, slates, and greywackes, quartz-porphyries, Keewatin schists, and Keweenawan diabase. The last-named cuts the ore-bodies, but has generally no connection with them. The mineral deposits of commercial value occur in the greywackes and conglomerates and in the coarser grained Keewatin schists. Those found in the quartz-porphyries are not payable. The rocks directly connected with the ore-bodies are highly schistose, and have undergone the usual alteration characteristic of the Porcupine field. The most conspicuous ore-bodies may be described as exaggerations of the lens type, and are much less in length than those of the Hollinger section. It was these huge masses of white quartz, dome-like in appearance, which gave the property its name. Two of the largest of these domes had surface dimensions of 125 ft.



PLAN OF 300 FT. LEVEL, PORCUPINE CROWN, SHOWING GEOLOGY AND INTRICATE BLOCK AND STEP FAULTING.

by 600 ft. Associated with the domes, which show the usual irregularity in horizontal and vertical extension, are large areas of mineralized schist, through which ramify irregular quartz stringers.

Development has now reached a depth of 1,150 ft., but practically no exploration other than by diamond-drills has been done below the 800 ft. level. The ore reserves at March 31, 1918, were estimated at 1,950,000 tons worth \$5·10 per ton, or a total of \$9,945,000. The report of the company covering operations up to March 31, 1919, indicates that these figures were at that time unchanged, no milling having been done in the meantime. The property has an excellent plant. In the early days of the mine, the ore was excavated in huge open-cuts, but as development proceeded downward the workings have been laid out at intervals of 150 ft., in a rectangular system, with the drifts north-east and south-west and cross-cuts north-west and south-east to 1,150 ft. The stopes are laid out across the ore-bodies in 75 ft. sections (60 ft. of stope and 15 ft. of pillar). The drifts are extended along the foot-wall and cross-cuts run below the pillars. Box-holes are raised every 25 ft. on either side of the cross-cuts to enter the bottom of the stope just at the edge of the pillars. The only timber used is in the chutes, the stope backs standing remarkably well. All the ore above the 8th level (850 ft. below the surface) is dropped down through passes to this level, which has become the main haulage and loading way. It here passes through a 36 by 54 in. crusher and is raised to the surface through the new large square shaft recently completed in the foot-wall side of the ore-bearing zone, measuring 17 by 12 ft., containing two 5-ton shipways 6 by 6 ft., cageway 12 by 6 ft., and one ladder and pipe compartment. From the crusher below the 8th level, the ore passes mechanically through a secondary crusher at the surface and thence to the mill.

Owing to the rise in the price of materials during the war, the mill was closed down from December, 1917, until the spring of 1919. Its capacity is 1,500 tons per day, and it is now treating about two-thirds of this amount. The treatment consists in the first place of stamping, tube-milling, and plate-amalgamation in water. The product from the plates is classified into three channels : (a) Slime, which after dewatering is agitated in cyanide solution and thence passed through Merrill filters to waste ; (b) sand, which is leached ; (c) concentrate, which is re-ground in tube-mills in closed circuit with classifier and amalgamation plate. The classifier overflow joins the overflow for slime treatment. The tonnage of Dome ore milled and the values extracted therefrom from the beginning up to the end of 1918 is given in Table 4. The Dome distributed dividends amounting to \$1,500,000 up to the end of 1917. None was declared during 1918.

The only other important property at present operating to any extent in the Dome section is the Dome Lake mine, lying to the south-west of the Dome. The deposits apparently resemble structurally more those of the

Pearl Lake group than those of the Dome. It has a milling capacity of 60 tons.

METALLURGICAL PRACTICE. — Although the ore of the various Porcupine mines is to a great extent similar in character from a metallurgical standpoint, the methods in use differ somewhat from mine to mine, due mainly to the varying conditions each mine has encountered during its individual history and development. In the early period of the life of the district when only ore at upper horizons was being treated, a considerable percentage of the gold was free and amalgamation alone was sufficient to extract most of the values. The original mills designed had, therefore, as the principal basis of their flow-sheets amalgamation, on plates, pans, barrels, etc. With the development of the mines in depth, this free character of the ore disappeared, and at the present time the Dome plant, among the bigger plants, is the only one using plate-amalgamation. There is reason to believe that when the Dome surface ore-bodies are exhausted and only ore from the lower levels treated it will also abandon amalgamation.

Ordinarily, 95% or even more of the gold in Porcupine is now extracted chemically by dissolving in it a weak solution (about 1 lb. per ton) of sodium cyanide. The process differs in the principal mills, as follows:

(*1*) Hollinger. The ore is all crushed and slimed in cyanide solution and the pulp concentrated on Deister slime tables. The pyritic concentrate is re-ground in tube-mills (separate), the pulverized pyrite joins the gangue-slime, and the whole is agitated by air.

(*2*) Dome. The ore is crushed and separated into sands and slimes. The sands are leached (South African practice) and the slimes agitated in Pachuca vats.

(*3*) McIntyre. All of the ore is slimed and kept in the tube-mill circuits until it is very finely pulverized and then subjected to air agitation.

Stage crushing is adopted by all the mills. The crushing equipment used by the main plants is as follows:

Hollinger. Gyratory crushers to 2½ in. particles, stamps to ¼ in. mesh, tube-mills to slime.

Dome. Gyratory and jaw crushers to 2½ in. ring, coarse product to stamps to ¼ in. mesh, fines to ball-mills to 10 mesh, tube-mills to slime.

McIntyre. Gyratory crushers to 3 in. ring, rolls to 1¼ in. ring, ball-mills to 10 mesh, tube-mills to slime.

Two companies, Hollinger and MacIntyre, are at present experimenting with tube-mills loaded with 1 in. steel balls instead of the usual 4 in. flint pebbles, and the results are said to be very promising. These tube-mills handle big tonnages of coarse ore and are making a very fine product, so desirable in the cyanidation of a heavily mineralized ore.

The gold-bearing cyanide solutions are separated from the pulp in most of the mills by the counter-current system of decantation through Dorr continuous thickeners. The Dome plant, however, is still using the Merrill pressure filters (square leaves) installed in 1912. The gold is precipitated from the solutions by zinc dust in all of the Porcupine mills. The Crowe vacuum system of precipitation is already in operation in some mills (McIntyre) or is about to be installed. In this process, the gold-bearing solutions are deprived of their air content by submitting them to 27 in. or 28 in. of vacuum, before they come in contact with the zinc. The consumption of zinc is reduced from 0·2 lb. per ton of solution to about 0·09 lb. or even less, which is an important saving, considering the price of zinc and the big tonnages of solution from which precipitation is necessary. It also delivers a considerably cleaner product to the refineries and makes an appreciable saving in this department.

The method of refining varies somewhat at the several plants. At the Hollinger, the gold-zinc precipitate is fluxed with iron oxide, borax, sand, and litharge, in a small water-cooled blast-furnace. The resulting lead bullion is cupelled. At the Dome, the precipitate is treated in a weak sulphuric acid solution, then smelted in a blast-furnace, with litharge, and the lead bullion cupelled. At the McIntyre, the precipitate is acid-treated (20% sulphuric acid), and then smelted with suitable fluxes in a carborundum-lined reverberatory furnace. The bullion of approximately 900 fineness is either shipped direct to the mint or further refined by introducing chlorine gas through the molten bullion.

As a general rule no milling costs in any plant exceed $1·25 per ton of ore, and, ordinarily, from 95% to 97% of the gold content in the ore is extracted at the principal mines.

COSTS.—Notwithstanding climatic difficulties, the costs at the principal Porcupine mines compare well with those prevailing at other gold-mining areas throughout the world. The total cost of ore per ton treated at the Hollinger amounted to $4·033 in 1916, to $4·439 in 1917, and to $4·937 in 1918. The total cost per ton for the Dome in 1916 was $2·634. The operating costs at the McIntyre for the year ending June 30, 1918, are given in Table 5.

Table 6 indicates how the mining costs amounting to $580,689 or $3·2563 per ton were distributed at the McIntyre.

HYDRO - ELECTRIC POWER. — Though nearly all of the properties operating at Porcupine have subsidiary steam plants, the power in use throughout the district is derived mainly from hydro-electric installations at Sandy Falls, on the Mattagami River, six miles north-west of Timmins in the western part of the Porcupine district, and at Wawaitin Falls, 11 miles south-west of Timmins. The capacity of the former is 2,500 horse-power and of the latter 7,000 horse-power.

PRODUCTION AND DIVIDENDS.—Table 7 gives the gross value of the entire production from the various mines of the district together with dividends paid up to the end of 1918.

CONCLUSION.—Porcupine is the youngest of all the world's great goldfields. During its ten years' career it has suffered many vicissitudes. It blossomed forth healthier than before after the terrific forest fires of its early history. It may equally be expected to develop with renewed vigour now that the world conflagration of war is passed. Lack of labour is impeding the growth of the larger and stronger mines, while the high price of materials, from which there is at present but little relief, prevents the reopening of many promising undeveloped or partly developed properties.

TABLE 4.—THE DOME MINES COMPANY, LIMITED.

Period ending	Milled tons	Total production $	Production per ton $	Total operating costs $	Costs per ton $
Prospecting days	Unknown	4,276·61			
March 31, 1913	101,812	1,043,994	10·25	534,038	5·25
March 31, 1914	145,305	1,204,597	8·29	615,513	4·24
March 31, 1915	248,550	1,055,496	4·25	752,207	3·026
March 31, 1916	347,640	1,778,958	5·117	889,594	2·559
March 31, 1917	459,530	2,171,784	4·726	1,241,862	2·702
December 1, 1917	247,000	1,030,758	4·173	686,180	2·778
Totals	1,549,837	8,285,691	5·346	4,719,396	3·045

TABLE 5.—McINTYRE PORCUPINE GOLD MINES, LIMITED.

OPERATING COSTS—YEAR ENDED JUNE 30, 1918.

	Total $	Cost per ton $
Mining—		
Exploration	10,200 64	0·0572
Development	151,442 93	0·8492
Breaking and stoping	419,045 61	2,3499
	580,689 18	3·2563
Crushing and transportation of ore	26,519 07	0·1487
Milling	161,201 40	0·9039
Repairs to buildings, etc.	8,383 73	0·0470
Heating, lighting, water supply	25,613 43	0·1437
Executive expense—head office	30,763 97	0·1725
Administrative and general expense at mine office	38,006 71	0·2131
Taxes, insurance and workmen's compensation	39,192 60	0·2199
Bullion marketing costs	7,958 48	0·0415
	918,328 57	5·1466

TABLE 7.—PRODUCTION OF GOLD AND SILVER AT PORCUPINE.

From the commencement to the year 1918.

Year	Ore Milled	Gold $	Silver Oz.
1910	1,060	35,539	19
1911	482	15,437	—
1912	83,725	1,730,628	15,060
1913	303,311	4,294,113	38,785
1914	558,084	5,190,794	47,980
1915	964,334	7,536,275	67,616
1916	1,330,562	9,397,536	91,505
1917	1,175,928	8,229,744	69,100
1918	816,037	7,767,907	68,216
Totals ...	5,233,523	44,197,973	399,281

TOTAL DIVIDENDS PAID BY PORCUPINE MINES

To December 31, 1918.

	$
Hollinger Consolidated Gold Mines, Ltd.	9,424,000
McIntyre Porcupine Mines, Ltd.	1,092,085
Dome Mines Company, Ltd.	1,500,000
Porcupine Crown Mines, Ltd.	840,000
Rea Consolidated Gold Mines, Ltd.	12,000
Total	12,868,085

TABLE 6.—McINTYRE PORCUPINE GOLD MINES, LIMITED.

ANALYSIS OF MINING COSTS.

—	Breaking and Stoping $	Drifting $	Cross Cutting $	Raising $	Sinking Stations and Sumps $	Winzes $	Total Cost $	Cost per Ton $
Labour	149,025	36,438	8,166	3,279	17,824	1,226	215,960	1·2110
Explosives	58,316	15,372	3,733	1,717	3,068	873	83,082	0·4659
Supplies	9,012	2,252	290	397	1,230	76	13,260	0·0744
Power	26,168	6,051	1,392	1,082	3,721	630	39,046	0·2189
Workshops	2,249	311	149	30	108	11	2,860	0·0161
Hoisting	89,856	9,627	2,674	1,069	3,209	534	106,971	0·5999
Timbering	19,038	...	...	523	5,239	132	24,934	0·1398
Rock Drill Maintenance..	9,375	2,163	576	432	1,730	144	14,423	0·0809
Sharpening Steel	12,314	2,841	757	568	2,273	189	18,945	0·1062
Pumping and Ventilating	17,870	1,914	531	212	638	106	21,274	0·1193
Assaying and Sampling	5,875	2,440	532	45	90	45	9,038	0·0507
Superintendence	6,602	628	196	117	235	78	7,860	0·0441
Surveying and Engineering	8,719	937	259	103	311	51	10,380	0·0582
General Mining Charges	2,056	220	61	24	73	12	2,448	0·0137
	416,480	81,198	19,333	9,607	39,755	4,112	570,448	3·1991
Exploration	...	...	...	...	...	...	10,200	0·0572
							580,689	3·2563

THE MANGANESE DEPOSITS OF TCHIATURI, CAUCASUS.

By W. H. RUNDALL, Assoc.M.Inst.C.E., M.Inst.M.M.

The author gives an account of the present position of the Caucasus manganese mines.

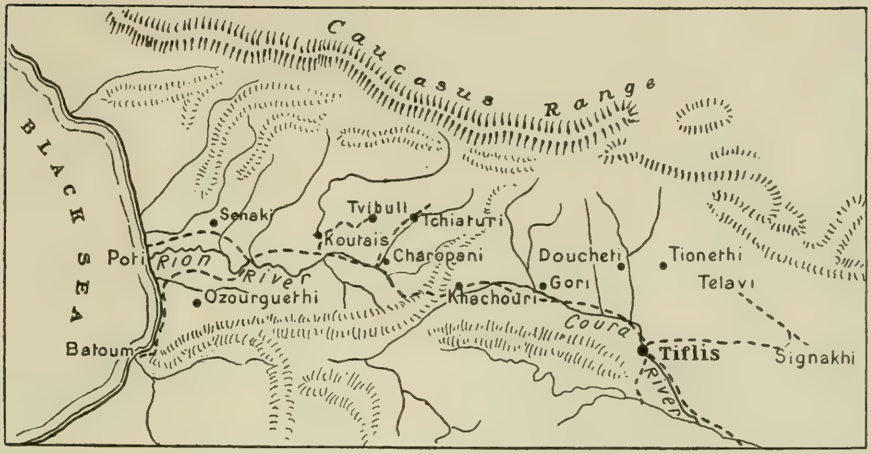
PRIOR to the war this district ranked with India and Brazil as one of the principal sources of the world's supply of manganese ores, and the deposit about to be described is probably the largest continuous deposit, as yet actually developed and producing, in any part of the world.

An article on the same district by August Muls appeared in the June, 1910, issue of the Magazine, and an interesting paper by Francis Drake in the Transactions of the American Institute of Mining Engineers, dated February 1898, describes the industry in the days of its early development. A paper by Mr. E. C. Harder, read in 1916 before the American Institute of Mining Engineers, made reference to these deposits, and in a contribution to the discussion on the paper, Mr. H. K. Scott made useful additions. A great deal of valuable statistical information about the mineral industry of the Caucasus generally, and the manganese industry in particular, is contained in a recently published book, "Mineral Resources of Georgia and Caucasia," by D. Gambashidze, F.R.G.S.

The description and details here given have been compiled from notes made on the spot during a visit to the district in question, and various other places of interest in the Caucasus, from which I have recently returned.

Tchiaturi is in the province of Kutais, Georgia, south of the main Caucasus Range. From 1801 to 1917 Georgia formed part of the Russian Empire. On May 26, 1918, the Georgians proclaimed their independence and organized for resistance against the advancing Turks. In this they were greatly assisted by the Germans, who obliged the Turks to retreat within the frontiers assigned by the Brest-Litovsk Treaty. Early this year the independence of Georgia as a republic was recognized by the Peace Conference, and in Tiflis, where I was at the time, great rejoicings and demonstrations took place. History, however, in these troubled times moves fast, and it remains to be seen whether the advance of the Russian Bolsheviks into the neighbouring republic of Azerbaijan, and the evacuation of Batum by the Allies, a policy now decided upon, may lead to the destruction of the recently organized Georgian republic as it has already led to the fall of the neighbouring republic of Azerbaijan.

The village of Tchiaturi, where the deposit is located, is 93 miles in a direct line due east from the Black Sea. At this point the Kvirila river has cut a deep gorge through a formation

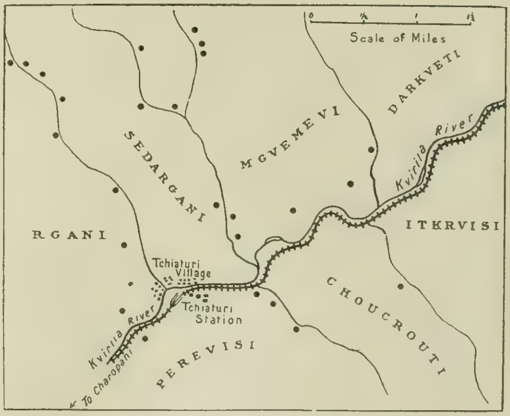


MAP SHOWING THE POSITION OF THE TCHIATURI DEPOSITS.

of massive limestone, the sides of the gorge rising precipitously in places to a height of six or seven hundred feet above the bed of the river. In the faces of the limestone cliffs there are many remains of ancient cave dwellings, approached by narrow paths hewn in the face of the cliff. The limestone is of a dead black colour, owing to the filtrations from the manganese deposits above.

According to the Russian Geological Survey, the Tchiaturi region consists of granitic rocks overlain by Tertiary marine deposits ("depots de la transgression marine Caspienne"). At the level of the bed of the river, and below the bed of massive limestone some 800 to 900 ft. in thickness, intrusive masses of diorite can be seen in places. Overlying the limestone, and to no great depth, are beds of soft sandstone and argillaceous, or calcareous, sandy shales. The beds of manganese ore lie at, or about, the junction of the massive limestone and the overlying sandstone rock, and would appear to be of sedimentary and detrital origin modified by secondary infiltration and enrichment.

The ore-bed varies in thickness from 3 or 4 ft. to as much as 8 or 9 ft.; it lies almost horizontal, and is wonderfully regular and very little disturbed by faults or contortions of the strata. The deposit is extensive, and the area over which exploitation has already been carried on, as evinced by the large number of mine workings, amounts to over 40 square versts (17½ square miles). It is split up and divided by the Kvirila river, the three main ravines running north and the two main ravines running south, forming seven areas. The ore horizon varies from 700 to 1,200 ft. above the main valley, and the general dip or trend is south-easterly.



TCHIATURI DISTRICT, SHOWING POSITION OF CHIEF WORKINGS.

Russian engineers have estimated the tonnage of ore available for exploitation at 200,000,000 tons. A rough estimate based on the area over which the deposit has actually been exposed by the existing mines and scattered outlying workings gives approximately 100,000,000 tons, from which one must deduct the 10,000,000 odd tons already exported from the district. From the point of view of available tonnage, therefore, the district is assured of a prosperous future for many decades.

The ore of the district is pyrolusite, containing 60–63% metallic manganese in its pure state, partly of compact crystalline structure and steel grey metallic lustre, but more generally amorphous and of a dull black or brownish colour. Wad also occurs extensively.

The following is a characteristic analysis given by Gambashidze:

	%
Moisture	1·61
Silica	6·67
Alumina	2·14
Manganese Peroxide	85·77
Manganese Protoxide	0·80
(Manganese Metal	54·83)
Lime	0·87
Magnesia	0·24
Barytes	0·68
Phosphoric Acid	0·40
(Phosphorus	0·17)
Iron Oxide	0·03
	99·21

The only mine being actually worked at the time of my visit is situated on the south-west side of the Chacrouti ravine, south of the Kvirila river. Prior to the war this had belonged to a German company, and is well laid out and equipped. It has now been taken over by a local Georgian syndicate which is working on a reduced scale and much below the full capacity output of the mines and works.

As this mine is an example of the best practise of the district, a brief description will be of interest.

The ore-bed at this point lies approximately 725 ft. above the Kvirila river at the contact of the limestone and the overlying sedimentaries, the outcrop being exposed all along the south-west side of the ravine. The mine is entered by a tunnel about 10 ft. wide by 6 ft. high and some 2,000 ft. in length, substantially timbered, driven perfectly straight, and furnished with a double track. An endless wire rope running on rollers between the rails controls the movement of the trucks. The trucks are of steel, about 14 cu. ft. capacity each. At the surface the trucks run on to tipplers and are dumped over large screens. The reject from the screens is picked over, and a limited quantity of coarse ore is selected for direct shipment; waste is picked out, and ore of too low grade for immediate shipment is broken up and thrown in with the fines. All the fines are washed down a concrete-lined steel chute to the valley below. At the time of my visit the ore was 8 ft. 9 in. in thickness at the working face, but was only being worked out to a height of about 7 ft. above the foot-wall. The reason for this was explained as being due to the difficulty in obtaining props of sufficient length.

The following section was noted at the face of the stope commencing from the top:

12 in. Ore locally known as "oolite," consisting of nodules of pyrolusite varying in size from $\frac{1}{16}$ to $\frac{1}{4}$ in. diameter, cemented together by an arenaceous calcareous gangue and merging at times into small concretions of massive ore.

6 in. Soft, earthy, brown ore.

4 in. Argillaceous layer of poor grade.

9 in. Good ore interspersed with streaks of grey and white clayey matter. If carefully mined and sorted this will give 48–50% ore fit for direct shipment. It is not suitable for concentration by washing owing to the contained clay.

14 in. Soft black, or chocolate-coloured ore, 45–50%.

9 in. Black ore containing a good deal of clayey matter. If carefully mined and sorted should yield 50% ore.

10 in. Hard black ore, slightly mixed with sand and clay.

20 in. Hard steel-grey to black ore, very clean. At least half can be sorted out of high grade for direct shipment.

Below this comes the solid limestone footwall.

The method of mining adopted is as follows: A pillar 100 ft. in width is left on each side of all main entrance galleries. Ventilation is provided for by parallel galleries, or holing to the surface where the surface contour permits of this being conveniently done. For the mining of the ore, galleries are driven out at right angles to the main haulage ways. The longwall system of mining is used, and as the distance between walls increases props are put in to support the roof. The limit of open width allowed is about 30 ft., and when this width is reached the central props are drawn and so gradually the roof is allowed to cave, the waste to be disposed of being first thrown back.

The miners work on the contract system and are paid by the square sagene (49 sq. ft.) of ore-bed mined. The contract price includes the removal and rough sorting of the ore, the loading of the same into the trucks (not the tramming), and the laying of the branch roads up to and along the working face, also the handling and disposal of the waste, which is not trammed to the surface. The contractor is provided free of charge with all the material and stores, such as timber, lighting, etc.; also all tools and the keeping of them in condition, such as the sharpening and re-helving of picks, etc. No explosives are used, as the ore is easily broken down by the pick.

No detailed information was available as regards cost of mining, but taking into consideration the price paid to the contractors, estimating roughly for the cost of tramming, timber, and stores, etc., and calculating roubles at the then current rate of exchange, I estimate n sterling that the cost per ton of ore trammed to the surface would work out at about two shillings.

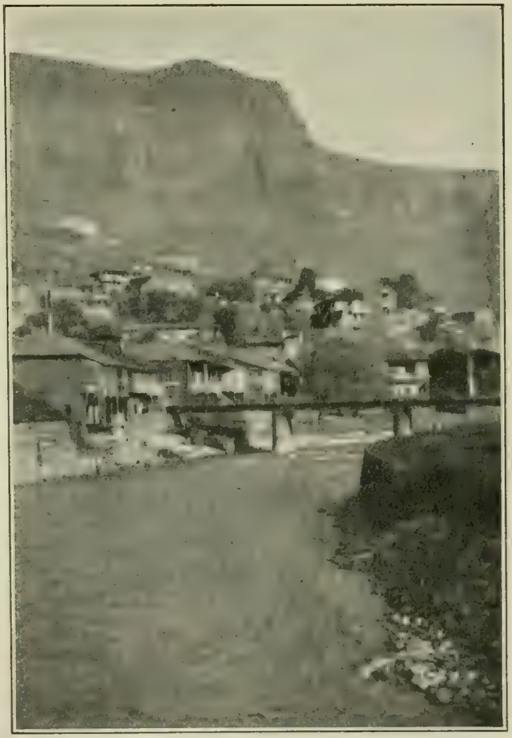
The ore-dressing plant is situated at the bottom of the ravine immediately below the mine. The plant is designed in three units, housed under one roof, each unit being capable of an output of 100–150 tons of washed ore per shift of 8 hours, full working time. Only one of these units was at work at the time of my visit, running one shift of 8 hours only. There is no crushing plant, the disintegration of the ore while being washed down the steep concrete launder from the mine, over 400 ft. vertically above, proving quite sufficient. The ore is first passed to 22 ft. revolving trommels (three in number, one to each unit), having 30 m.m. holes. The coarse reject from these trommels passes to revolving picking tables, one table to each trommel. Each table is attended by four men, and all ore fit for direct shipment is picked out, the remainder being rejected as waste. The screenings from the large trommels are further classified by revolving trommels having holes as follows: 20 m.m., 10 m.m., 6 m.m., 3 m.m., 1½ m.m. This classified material is fed to jigs of the Hartz type as follows: Four 3-compartment coarse jigs, treating the coarse material of all three units; and for each unit: four 3-compartment medium jigs, and two 3-compartment fine jigs. For the further classification of the ore to the fine jigs each unit is provided with spitzkasten. The jig floor is placed at a sufficient height to enable large hoppers to be installed below for the collection of the washed ore and the tailings.

The washed ore is trammed direct from the above-mentioned hoppers, through a long tunnel, to the loading dump alongside a railway siding capable of holding a large tonnage. The tramming through the tunnel to the siding is done by an endless travelling cable, the tunnel being furnished with double tracks. The coarse tailings are trammed from the waste hoppers and dumped into the ravine below. Owing to the fouling of the Kvirila river in the past by the slimes from the washing plant, it is not now permitted to discharge the fine tailings and slimes direct into the ravine. The method adopted is to impound these slimes in large masonry settling tanks and they are thus discharged at intervals, instead of continuously, into the ravine. From the ravine they, of course, eventually find their way into the river and it is difficult to see what is gained by this system of impounding. No attempt is made to treat the fine slimes on tables or frames.

The power is furnished by two Körting oil engines, one of 150 h.p. and one of 75 h.p. Electric current is generated for the lighting of the plant, mine-floors, buildings, etc.

The loss of manganese in the washing process is very considerable. Under the best conditions a recovery of 67% is claimed. Soft earthy ores mixed with clay should not, of course, be fed to the plant, and this is avoided as far as possible.

A parcel of 752 tons (dry weight) of washed ore from this plant was sampled while loading on board a steamer for export with the following result: Manganese metal 54·95% = approximately 86·80% peroxide; silica 5·35%.



TCHIATURI VILLAGE.

The question of the advisability, or otherwise, of concentrating the ore by washing may be considered as debatable. So many factors enter into the question that it is outside the scope of this article. It hinges upon the relation between cost, freight, and realization values, and also upon a comparison between the loss in tailings in the one case and the loss caused by careful sorting and selection in the other. The only British-owned company in the district has no washing plant, and their manager informs me that when working prior to the war they could keep their shipments up to 48% Mn and over without any system of concentration, but by encouraging clean mining and sorting of the ore by a system of bonuses, over and above the contract price, based on the grade of the ore delivered by the contractors.

Of course, where the ore is destined for sale to the chemical industry and its value depends upon a very high percentage of peroxide (90% or over) and its freedom from impurities, the issue is clearly in favour of some system of concentration. Also at the present time, and taking into account the high rates of freight and other charges, every advantage is to be derived from keeping shipments up to as high a grade as possible.

For the transport of the ore from the mines and washing plants to the railway at Tchiaturi all the larger establishments have their own incline tracks, or wire rope-ways, to the dumps, or loading platforms, alongside their own railway sidings. The smaller concerns, and those less favourably situated for direct connection with the railway, have recourse to the local transport drivers who undertake the transport of the ore along the steep and narrow mountain tracks to the railway, on a contract basis according to distance. For this class of transport light two-wheeled ox-carts, furnished with long wicker-work baskets holding 70 poods (about 23 cwt.) are used. These are locally known as "arbas," and have the advantage that the loaded trip is all down hill.

The cost of the ore delivered on rail in the case of the favourably situated mines with adequate mechanical transport arrangements does not exceed 5s. 6d. per ton. In the case of the outlying mines transporting the ore in ox-carts the cost is of course proportionately higher.

In 1893 the Russian Government completed the construction of a narrow-gauge railway from Tchiaturi to Charopani, a distance of 26 miles, at a cost of about £150,000. This railway follows the Kvirila river down to its junction with the river Rion at Charopani. The Rion is a large and important river flowing into the Black Sea at the port of Poti, but owing to its swift and turbulent current is not navigable.

At Charopani the narrow-gauge railway from Tchiaturi establishes connection with the main Trans-Caucasian Railway running from Baku, on the Caspian Sea, to Batum and Poti on the Black Sea. At this point the trucks on the narrow-gauge line are shunted on to a high-level siding parallel with a low-level siding on the broad-gauge line, and the transfer of the ore to broad-gauge trucks is effected by chutes which direct the stream of ore into the trucks below.

The railway freight, Tchiaturi to Poti, was in March of this year about 14s. 8d. per ton when calculated into sterling at the then current rate of exchange. To this has to be added the cost of handling at Charopani.

Poti, on the Black Sea, is the principal port of shipment. Here the trucks are run on to the wharf alongside the steamers, and extensive accommodation for dumping the ore on and near the wharves is also provided. The stocks of ore awaiting shipment at the port of Poti are very large, amounting to some hundreds of thousands of tons at the present time. These stocks were accumulated before the war. The handling and stowing on board at Poti is done by contract at an arranged price per ton; at the present time the cost is high owing to the exorbitant demands of the local Dockers' Union.

A charge on the industry, apart from the cost of production, transport, port-dues, etc., is the local association of producers' tax. The Association of Manganese Producers, whose authority was recognized by the Russian Government before the revolution, and now recognized by the present Georgian Government, was organized in order to co-ordinate and assist the industry by the improvement of roads, water supply, lighting, the keeping of records and statistics, etc. They are authorized to exact a tax, at a rate which can be varied within certain limits, on all ore exported. This tax at present amounts to approximately 2s. per ton on ore destined for the metallurgical industry, and 4s. per ton on ore destined for the chemical industry.

Owing to the constantly fluctuating rate of exchange, and the unstable conditions as to the cost of labour, etc., at the present time, it is not possible to give reliable figures for the cost per ton of ore f.o.b. Poti. The following is an approximate estimate, based on the freight and other charges at the end of March last, for ore destined for the metallurgical industry from a fully equipped and favourably situated mine:

	Cost per ton. £	s.	d.
Mining, Dressing, Transport, and Loading on Rail		5	6
Railway Freight Tchiatari to Poti		14	8
Handling at Charopani		1	0
Station and Weighing Charges, Port Dues, and Loading on Board		3	0
Association of Producers' Tax ...		2	0
Total Wet Weight	£1	6	2

This cost is equal to about 7d. per unit on ore averaging fifty per cent manganese metal, dry weight.

The sea freight to European ports is, of course, a variable factor, and is governed by the demand for freight ruling at the Black Sea ports generally. At the present time freights are extremely high, and they will, of course, continue to be so while the political situation in Russia and Turkey prevents the resumption of normal trade.

In 1913 the mining and export of manganese ore from Tchiaturi had risen to very important proportions, amounting in that year to over one million tons. The British ports to which the ore was principally shipped were Middlesbrough, Garston, Manchester, and Mostyn. The largest shipments went, however, to the continental ports of Rotterdam and Antwerp, these shipments being destined for Germany. The war of course completely paralysed the industry, and although a resumption of shipments has been made it is on a very small scale at present.

The Georgian Government, which is absolutely communistic in its policy, has now nationalized all minerals, and has limited the ownership of land to 7 desatines (19 English acres) per individual owner. The export of all products of the country, including minerals, is controlled by the Government. The control and regulation of the export of manganese ores is in the hands of a special committee authorized by the Government and known as the Georgian Manganese Combine. The combine claims to own two-thirds of the manganese-bearing area. Independent producers wishing to export their ore must do so under licence from the combine, who will fix the price per unit to be advanced against the ore placed f.o.b. Poti, based on the cost of production, plus freight, loading charges, local taxes, and dues, etc. After realization at the port of destination, and the deduction from the sum realized of all freight and other charges, the Georgian Government tax of 25% of the net profit, and the amount already advanced against the ore f.o.b. Poti, any balance will be paid to the producer.

Firms or individuals wishing to purchase ore in Georgia for shipment abroad cannot deal direct with producers, but must apply to the Government, who will specify terms in conjunction with the combine.

The foregoing will have made it evident that from a commercial point of view the leading factors are the cost of land and sea transport, taxation, etc., and that the mining and treatment of the ore is a merely fractional part of the cost of the ore up to the time of its realization abroad. Any improvements or economies, therefore, in this department play but a small part in the net results.

From the point of view of tonnage available for exploitation, facility of working, and the extraction of ore of excellent shipping grade at low cost, the Tchiaturi district is very favourably circumstanced. The future prosperity of the industry is so completely bound

BRIDGE OVER KVIRILA RIVER, WITH ELECTRIC LIGHT PLANT ADJOINING.

up with the question of fluctuations in the market value of the product, the cost of transport to the available markets, and the attitude and exactions of the Government of Georgia, that it is difficult to forecast its future possibilities, and the influence of supplies from this source on the markets of the world. At present prices, granted a continuance of political stability in Georgia, and prospects of some reduction in ocean freights, the industry should gradually again take its place among the world sources of manganese ore.

RESEARCH IN METAL MINING

By ALEX. RICHARDSON, M.Inst.M.M.

The Author makes suggestions for the inauguration of systematic research in connection with Metal Mining.

THE amount of attention directed to research in metal mining has never been very great; and now that the pressure of national necessity to preserve national existence has largely spent its stimulating force, there is a danger that laissez-faire will again cast its baleful shadow. This is a contingency that cannot be viewed with equanimity; for, with working costs steadily mounting, it is essential that current mining practices should be critically examined with a view to the elimination of, or improvement in, those factors which, by encouraging inefficiency, raise the operating cost. Apart, too, from the direct commercial benefit that would accrue as a result of a betterment of practice, it would seem that the time has now arrived when the industry should consider whether a scientific examination of fundamental principles might not prove a speedier way of arriving at a solution of the problems that confront it than the empirical methods which have brought it the success it has already achieved. Moreover, the rate of elevation of mining from a craft to a science would be increased by a greater infusion of the scientific spirit, and, as a consequence, the value of the mining engineer to the community would be more widely recognized.

Many people regard research as a purely academic affair, one in which a test-tube, microscope, or other standard laboratory instrument figures prominently, and which can only be properly attempted by a spectacled investigator with various combinations of letters after his name; a refined form of activity, in fact, which does not appear to have much connection with the rugged business of mining. When it is pointed out that the term means the discovery of facts by the agency of an investigation conducted on scientific lines, it will be realized that its application should prove as productive of a remunerative crop in the field of mining as in any other.

The different branches of mine work are so interrelated and interdependent that any dogmatic pronouncement regarding the relative importance of each in the general scheme would be unlikely to meet with unanimous acceptance; it might, indeed, prove to be the nucleus of a volume of warm argument. For this reason it is not easy to say off-hand in which directions research can be most profitably instituted, and which problems most demand solution. It will, however, be an aid to the envisagement of the subject to pass in review some of the chief mining activities. These are given in the following tabular statement.

SYNOPSIS OF MINING.

Geology:

Petrology.	Faults.
Mineralogy.	Dykes.
Ore deposits.	Maps.
Lodes.	Records.

Prospecting:

Surface indications.	Boring appliances.
Methods of search.	Surveying bore-holes.
Boring.	Testing and valuing ground.

Exploitation:

Shafts: position, form, size, lining.	Bins.
	Pillars.
Shaft sinking.	Mining methods.
Shaft equipment.	Sampling.
Underground lay-out.	Surveying.
Stations.	Plans.
Cross-cuts.	Power-transmission.
Drives.	Safety measures.
Rises.	Rescue work.
Winzes.	

Breaking ground:

Drill steel.	Excavating machinery.
Hand tools.	Hydraulic mining.
Machine drills.	Dredging.
Methods of drilling.	Stopes.
Explosives.	Shovelling.
Blasting.	Tramming.

Supporting excavations:

Pillars.	Concrete.
Packs.	Metallic supports.
Hydraulic filling.	Methods of using supports.
Timber.	
Masonry.	Mine subsidence.

Hoisting:

Steam winders.	Cages and skips.
Electric winders.	Safety appliances.
Compressed air hoists.	Signals.
Headgears.	Hoisting systems.
Ropes.	Loading chutes.

Haulage:

Steam haulage.	Haulage systems.
Electric haulage.	Conveyors.
Compressed air haulage.	Pipes and launders.
Oil locomotives.	Cars and trucks.
Rope haulage.	Tracks.
Ropes and chains.	

Drainage:

Engines.	Drainage levels.
Pumps.	Bailing.
Pipes.	Dams.
Sumps.	Acid water.

Ventilation:

Natural ventilation.	Mine gases.
Mechanical ventilation.	Testing mine air.
Ventilating appliances.	Dust prevention.
Efficiency of fans.	Cooling air in deep mines.

Lighting:

Candles.	Acetylene.
Electric light.	Gas.
Portable lamps.	Oil.

Ore dressing:

Washing.	Classifying.
Sorting.	Concentrating.
Breaking.	Magnetic separation.
Crushing.	Flotation.
Grinding.	Efficiency calculations.
Screening.	Flow sheets.

Labour:

Principles of employment.	Education.
	Native labour.
Modes of payment.	Foreign labour.
Clothing.	Strikes.
Hygiene.	Arbitration.
Recreation.	Contracts.

Legislation:

Mining laws.	Royalties.
Ownership.	State aid.
Taxation.	Mine inspection.
Works regulations.	Department of mines.

Surface works:

Works buildings.	Power plant.
Railways.	Roads.
Tramways.	Sanitation.
Offices.	Recreation club.
Rooms.	Sports ground.
Cottages.	General lay-out.
Dams.	

Economics:

Prospectuses.	Amortization.
Company organization.	Supplies.
Reports.	Mining nomenclature.
Statistics of resources and production.	Standardization.
	Monographs.
Costs, prices, and profits.	Text-books.
Weights, measures, and currencies.	Translations.
	Societies.
Principles of management.	Education and training.
	Teaching institutions.
Mine accounts.	Co-operation.
Mine valuation.	

A careful consideration of the above synopsis will disclose the existence of many unsolved problems. Among these, to take a few that readily come to mind, may be mentioned the following:

Improvement in present and discovery of new methods of search for ore deposits where surface indications are slight or absent.

The preservation of timber underground, or its replacement by a more economical substitute.

The development of the rock-drill, with special reference to a rotary type.

Reduction of the waste of explosives by means of the elucidation and application of the laws governing their use.

The devising of a system of mine taxation to which the epithet "equitable" could be unreservedly applied.

The standardization of methods of presenting statistical data to enable the construction of informative comparisons between machine and machine, mine and mine, and district and district.

The preparation of monographs to bridge over the serious time-gap that forms between the adoption of an innovation in practice and the appearance in text-books of information regarding it.

The translation of foreign publications of outstanding merit.

It would not be difficult to suggest several other promising lines of advance; the difficulty would lie rather in keeping the number of suggestions within reasonable limits. Assuming, then, that the field of research, or some corner of it, is worthy of cultivation, what will be the most suitable procedure to adopt? There are many roads of approach. Probably the most effective initial step would be the issuance by the society chiefly concerned of a carefully prepared questionnaire to its members. From an analysis of the replies received, certain points would emerge indicating common needs. This analysis could form the basis of a paper, the discussion of which could not fail to elicit further information of value, and to assist in determining the relative urgency of the problems awaiting attack. It would then be for the industry to decide whether or not the matter was of sufficient moment to call for its active business participation. If a favourable verdict was returned, the next step might be the formation of a research association working under Board of Trade licence. An approved association confers the important advantage of securing to the contributing firms remission of taxation on sums subscribed by them; profits devoted to research so organized are recognized by the surveyors of taxes as business costs, and are exempt from income and excess profits taxes. At this stage the question of inviting Government financial assistance is one that is likely to arise. If such assistance is secured a measure of Government control necessarily ensues, which may tend to cause some delay. On the whole, it is perhaps better for an association to be independent of grants from parliamentary funds. The industry should be strong enough to be able to maintain this independence, for although the amount of metal mining carried on in the United Kingdom is comparatively small, the amount financed and controlled from there is very large.

The preliminary spade-work done by the society would enable the association to apportion the weight to be given to the several more unanimous recommendations for research, and to select the one or the few on which to initiate early action. The way would then be clear for the preparation of an estimate of the first year's working and of the amount of the first annual contribution of each of the subscribing bodies. The utilization of the funds subscribed could be left in the hands of a board of control. The members of this board should receive fees for attendance, and retire by rotation, much on lines followed by the directorates of mining companies. Their number might be limited to six in the first instance. A large board almost always leads to dilution of control and weakening of interest. On the board would devolve the duty of appointing a director of research, an appointment calling for the exercise of a good deal of judgment, for on the selection much would depend. As research is an affair of men, not of machines, the possession of tact should be a noticeable item in the schedule of qualifications of such an officer. He should, of course, have a good technical knowledge of the various aspects of mining both above and below ground, and, in addition, a real affection for it. Business, administrative, and secretarial experience is very desirable. A temperament buttressed with enthusiasm, but not too sanguine to accept readily putative discoveries of uncritical persons, and sufficient scientific training to discriminate between the savant and the charlatan, are useful adjuncts. As occasion demanded, and in consultation with the director, the board would gradually appoint the office and technical staff.

Before embarking on any research, it is advisable to obtain a record and an analysis of all previous work bearing on the research contemplated. A bibliography in card form is well adapted to exhibit this information in a way suitable for quick and easy reference. It supplies a standpoint from which to view in proper perspective the ground to be covered, and eliminates the danger that a line of inquiry might be followed and time and money wasted in the pursuit of an investigation which some little-known record had shown to be fruitful of disappointing results. In addition to its value as a corrective to uninformed optimism, a list of references stimulates suggestions for future work, and, when published in annotated form, constitutes a valuable work of reference for all interested in the subject dealt with.

In considering the subject generally, it is well to bear in mind that a research is an adventure the outcome of which no one can predict. There can be no certainty that a discovery will result from an expenditure of funds; but there is a reasonable probability of its doing so if the research is vigorously conducted, just as in the development of the mineral resources of a new country, the greater the zeal of the explorers the more likely is a pick to stick fast within a welcome nugget. Even if a research fails to unearth anything of immediate practical value, it cannot fail to generate a wave of scientific thought in a large circle of workers and in a still larger circle of interested spectators, the indirect benefit of which must be considerable. Research directs thought along new paths, and acts as a cure to grooviness of outlook, which is the negation of intellectual activity. Its value lies not only in the knowledge that it gives, but in the capacity to get knowledge that it breeds. And if mining is to succeed in securing the position among the professions to which it is entitled, it will be by some such means as this.

NEWS LETTERS.

VICTORIA, B.C.

July 22.

BRITISH COLUMBIA OUTPUT.—The annual report of the Minister of Mines for British Columbia for the year 1919 has just been issued. The report contains 393 pages and comprises a résumé of the mineral industry of the province, the individual reports of the six resident mining engineers, the mining recorders, the gold commissioners, and the mine inspectors; a brief account of all operating mines and collieries that have not been covered in previous reports, and an account of the accidents that have happened in mines and collieries during the year. As usual, the report is well finished typographically and well illustrated with half-tone reproductions of mines and dressing plants, sketch maps, and flow-sheets of ore-dressing and metallurgical operations.

The following table gives the revised output of the mineral production for the year, and also, for comparison, of the two previous years:

BRITISH COLUMBIA METAL AND MINERAL OUTPUT.

	1917		1918		1919	
	Quantity	Value	Quantity	Value	Quantity	Value
		$		$		$
Gold placer .... oz.	24,800	496,000	16,000	320,000	14,325	286,500
Gold lode .... oz.	114,523	2,367,190	164,674	3,403,812	152,426	3,150,645
Silver .... oz.	2,929,216	2,265,749	3,498,172	3,215,870	3,403,119	3,592,673
Lead .... lb.	37,307,465	2,951,020	43,899,661	2,928,107	29,475,968	1,526,855
Copper .... lb.	59,007,565	16,038,256	61,483,754	15,143,449	42,459,339	7,939,896
Zinc .... lb.	41,848,513	3,166,259	41,772,916	2,899,040	56,737,651	3,540,429
Coal .... long tons	2,149,975	7,524,913	2,302,245	11,511,225	2,267,541	11,337,705
Coke .... long tons	159,905	959,430	188,967	1,322,769	91,138	637,966
Miscellaneous products	....	1,241,575	....	1,038,202	....	1,283,644
		37,010,392		41,782,474		33,296,313

The table differs materially from that issued early in the year in the preliminary estimate of the mineral production of the province. The final figures for the lead production are some 2,660,000 pounds and for copper 3,520,000 less, and for zinc some 13,000,000 more than the preliminary estimate. While the latter, of course, as the name implies, only professes to be an approximation, unless the guesses are a little less wild than those that appeared this year, it is difficult to see that it served any useful purpose. The zinc figures which appear in the final report are open to some criticism. It may be asserted safely that the Consolidated Mining & Smelting Company produces not less than 80% of the zinc output of the province, and in that company's report for the 15 months ended December 31, 1919, it gives its zinc production as 30,743,416 pounds, which would be equivalent to about 25,000,000 pounds for the 12 months. When the other sources of production are taken into consideration, this figure seems to corroborate the Dominion Department of Mines' estimate of 31,738,850 pounds. How the provincial Bureau of Mines arrives at 56,737,651 pounds it is difficult to understand.

All districts have shown a marked decline over the average production of the two previous years. This, of course, was expected, owing to the general slump in the prices of base metals since the armistice and the fact that British Columbia is essentially a base-metal province. The so-called non-metallic minerals have shown an increased production. Some 5,000 tons of fluor-spar was produced from the Rock Candy mine; and nearly 8,000 tons of magnesium carbonate was produced, most of it coming from the Clinton district, where immense deposits of the mineral have been proved by diamond-drilling. The Nickel Plate mines at Hedley produced arsenic to the value of $21,000 as a by-product in the production of gold. Hill 60 mine, in the Cowichan district, produced 500 tons of high-grade manganese ore, and would have produced a much larger quantity but for lack of transport.

THE GRANBY Consolidated Mining, Smelting, & Power Company has undergone a change of management, R. F. M. Sylvester having retired as managing director because, it is said, he was desirous of adopting a more progressive policy than his fellow directors cared to pursue. The office of managing director has been abolished, H. S. Munroe has been appointed general manager, and E. P. Mathewson consulting metallurgist.

DOLLY VARDEN.—The Taylor Mining Company and the Dolly Varden Mines, Ltd., have come to an agreement with regard to a settlement, which, it is understood, is more liberal than the terms arranged by the Provincial Government, and now the Dolly Varden mine is securely in the hands of the Taylor company. The 18 miles of railway from the mine to tide-water is being laid with a heavier rail, two new 20-ton locomotives have been added to the rolling stock, and at least one train of about 90 tons of ore, and often two, are sent to Alice Arm each day. A hydro-electric plant is to be built at Clearwater lake to supply power and light to the mine and the district generally. The mine is said to be in excellent condition, and, at the present time, gives every promise of making a really big silver mine.

THE PREMIER mine, in the Salmon River district, shipped some 1,500 tons of ore running between $270 and $300 per ton during the winter, and but for a labour trouble, which hampered production during the greater part of the shipping season, the output would have been considerably greater. It is expected that the concentrating plant which is being built at the mine will be put into operation before the end of the present year. A large amount of milling ore was produced with the high-grade, and next winter the mine will be shipping both high-grade and concentrate. Nine diamond-drills are in operation at the mine, and as soon as new faces and stopes are opened up more men are to be put on. About 150 are employed at the present time.

There has been a big rush of prospectors both to the Salmon River and Alice Arm districts, but, up to now, the Dolly Varden and the Premier are the only two real mines. There are many promising prospects that ultimately may become mines.

LABOUR.—There has been a good deal of labour trouble throughout the province, particularly in the Slocan district, which, on account of it, at the present time is very short of labour, and consequently production is being retarded.

THE CONSOLIDATED MINING & Smelting Co. has re-started its copper plant, which has been idle for some months. During the shutdown, the plant has been remodelled, the capacity of the refinery increased from 20 to 50 tons of refined copper per day, and a copper rod and bar mill is being added. It is stated that the company's Rossland mines, at which only development work has been going on for some time, are to start shipping again in the near future. The company has abandoned its wet magnetic concentration plant, which has been operating on its Sullivan mine ore, in favour of differential flotation. The plant has been dismantled and another experimental flotation plant is being erected in its place. The company has broken ground for the 1,500-ton concentration plant, at Trail, in which its Rossland mines ores are to be treated, and the Canadian Pacific Railway is building a spur line with a down grade all the way from mines to concentration plant.

TORONTO.

August 13.

PORCUPINE.—Though production is still somewhat curtailed by labour shortage, conditions in this respect are improving, and the companies are able to increase efficiency by picking their men. Mining costs have been considerably increased by the payment of higher wages. It was expected that the increase in operating expenses from this cause could be kept down to 25c. per ton, but the figures for recent operations at the Hollinger Consolidated show that this was an underestimate, and the additional cost will be about 50c. per ton. An experiment, looking to economy in material, is being tried by the Hollinger and Dome mines, which have hitherto been using for gold recovery the high-grade cyanide imported from Glasgow. A low-grade cheap cyanide manufactured in Canada is now obtainable, and is being used with satisfactory results in many of the Cobalt mills. The gold-mining companies are now testing it, and should it be found suitable for the process, the companies will be able to effect a considerable saving, as the price of the Scotch cyanide has lately been increased. The option held by the Dome mines on the Dome Extension adjoining expires on September 15, and there is much speculation as to whether it will be exercised or allowed to lapse. A large ore-body has been encountered by diamond-drilling at a vertical depth of 1,150 ft. on the boundary of the two properties, having a dip into the Dome Extension. A gold content of \$7·94 per ton is indicated, and work is being done to confirm this result, the outcome of which will be an important factor in determining the action to be taken on the option. The Davidson Consolidated has been closed down, pending plans for financing operations on an extended scale. At the McIntyre an ore-body, opened up at the 1,125 ft. level, has a width of from 9 to 10 ft. and covers a gold content averaging \$18 to the ton. It has been followed for a quarter of a mile and found to extend into the Jupiter claim. Gold has been discovered by diamond-drilling at a depth of 1,600 ft. The McIntyre has bought the Blue Diamond coal mines at Brule, Alberta, capitalized at \$1,500,000, and having an area of 3,300 acres, and has also taken an option on the Canadian Coalfields in the same vicinity with a much larger area, capitalized at \$10,000,000. The Porcupine Vipond-North Thompson has disposed of 200,000 treasury shares to a syndicate at 15 cents, with an option on 200,000 more for 30 cents at six months, and a further option on another 200,000 for ten months at 50 cents. This will enable the company to resume development. A new company is being organized to take over a number of claims acquired by the Bewick-Moreing interests in the early days of the camp.

KIRKLAND LAKE.—The Lake Shore during June produced \$37,546 from the treatment of 1,535 tons of ore, being an extraction of \$24·46 per ton. The total production for the first half of the year was \$244,710. The annual statement of the Kirkland Lake for the year ended May 31 showed earnings of \$159,777, with operating expenses of \$135,278, and profits of \$24,499. Little work was done for the first five months of the term owing to the strike. The production from January 1 to May 31 amounted to \$107,071, the mill running at about two-thirds capacity, working costs being \$6·21 per ton. On March 1 it was estimated that between the 300 and 700 ft. levels there were 120,000 tons of ore in sight, and recent development has added materially to this amount. At the annual meeting it was announced that a very rich strike had recently been made on the 400 ft. level, channel assays across the face of the vein for a distance of 4 ft. showing gold contents of $200 and upwards per ton. At the Wright-Hargraves good progress is being made with the construction of a mill. The machinery is being installed and the mill, with a capacity of 150 to 200 tons, is expected to be in operation before the end of the year. The Bidgood has picked up the vein, which had dipped out of the shaft, by cross-cutting at the 100 and 200 ft. levels. At the latter depth it had widened to 16 ft. The Orr company has purchased the assets of the Kirkland Porphyry Mines, Ltd., which went into voluntary liquidation, and the property will shortly be reopened. The new mining plant of the Hunton Kirkland has been installed, and the main shaft will be put down to the 300 ft. level, at which point the first lateral work will be undertaken.

COBALT.—The Gillies Timber Limit, a tract lying south of the silver-producing area, was thrown open to prospectors on July 20, and in a few days had been practically all staked. Most of the silver-mining companies have latterly been storing their bullion in the hope of an increase in the price of silver, and the vaults of the mines are estimated to contain some three million ounces. The Nipissing during June produced silver valued at $182,111, and shipped bullion and residue from Nipissing and custom ores of an estimated net value of $129,315. At the Bailey a shoot of high-grade ore has been encountered at the 5th level, about 6 in. wide and carrying upwards of 1,500 oz. to the ton. The Timiskaming has installed an oil-flotation system for the treatment of a large quantity of tailings. A large body of high-grade ore is being opened up on the Provincial. It has been driven on for 50 ft. on the 200 ft. level and proved by rises for 50 ft. above the level. The La Rose has entered an action against the Mining Corporation of Canada and the Cobalt Reduction Co. to recover damages for the alleged conversion by defendants of tailings from the plaintiff's ore deposited by the Northern Customs Concentrator on the bed of Cobalt Lake or on lands leased by the Cobalt Townsite Co. and the Northern Customs Concentrator.

GOWGANDA.—There is little activity at present in this district, many of the properties having suspended operations on account of the high cost of labour and supplies. The Miller Lake-O'Brien and the Trethewey are producing steadily. The Big Four will meet the difficulty experienced in obtaining fuel by installing an oil-driven mining plant. An important pyrites deposit has been found on this property, and it is to be developed.

KALGOORLIE, W.A.

July 6.

MOUNT MONGER DISCOVERIES.—Some time ago the Assistant State Mining Engineer (Mr. T. Blatchford) went to the Mount Monger district to investigate the gold discoveries made there. The Minister for Mines, Mr. J. Scadden, stated that owing to his absence in Melbourne and the fact that a second sampling was necessary, there had been a certain amount of unavoidable delay in the publication of the report. The report has been received, but it is not proposed to publish it in detail, as owing to little actual development having taken place, it would probably be misleading to the general public.

The report deals exhaustively with the geological conditions of the field. The belt on which the main group of leases are pegged consists of a series of rocks running with a marked parallelism in a general north-west south-east direction. These rocks can be classified under four main headings, serpentines, quartz-porphyries, massive and foliated greenstones. The central or serpentinous rocks form the main ridges passing through the Lass O'Gowrie, Great Hope, and Mount Monger Proprietary and Mount Monger Leases. They are probably derivatives of a very basic rock, and now consist of talc rock, talc chlorite rock, and olivine serpentines. The width of this belt varies from 2,000 to 4,000 ft. Except in the northern section shearing in this belt of rocks is almost absent. On the Mount Monger Proprietary lease, however, there is evidence of slight foliation across the belt, which is probably due to the intrusion of the greenstone. To the east is a belt of highly sheared quartz-porphyry, the eastern boundary of which is marked by alluvium which forms an extensive salt bush flat. West of the serpentine is another belt of crushed quartz-porphyry contiguous to the serpentine as far north as the Great Hope mine, but separated farther north by a wedge of more or less sheared greenstone. West of the western porphyry is a massive complex of unsheared greenstone (epidiorite), which forms a rather conspicuous range of hills. As some of the greenstones intrude the serpentine belt, it is evident that the latter is the older rock, but the relative age of the porphyries has not been determined.

The mines may be readily classified, with one slight exception, under two headings in accordance with their geological position : (*a*)

Those in the porphyries; and (*b*) those in the serpentine belt. In the former the payable gold has been found exclusively in quartz leaders, and such have been worked for years past, as, for example, Creedon's Welcome and the Daisy mines. The walls encasing these quartz veins have also been found to contain gold, but so far not in payable quantities. In the second class, the serpentine, talcose, and talc chloritic rocks, gold has been found both by loaming and in the massive rocks themselves.

A considerable amount of sampling has been done in the workings of this belt with varying values, as a result of which Mr. Blatchford has arrived at a rather definite conclusion that, though occasional high assay results in gold have been obtained in several instances throughout the belt, such values are isolated and give no sign at present of continuity. He further considers that the occurrence of the gold is due to a process of segregation in the rock mass much in the same way as the magnetite crystals have been formed from the iron salts liberated from the rock-forming minerals in the process of alteration. So far, these segregations have only been found in isolated patches both in the talcose and chloritic rock, and until some development takes place where the high values can be proved to be continuous for a considerable length and breadth, the publication of high results only tends to misrepresent the true position. In the other two classes of rock—the greenstones—gold has been found in one instance only, namely, in the Great Hope. Here the shaft was sunk in a quartz-dolerite, which has apparently intruded the serpentine belt from the west. Further development is necessary here before a definite opinion can be offered as to the significance of this occurrence.

The sampling discloses great variations from mere traces to high values; and it should be emphasized that a report of high values is no indication of their continuance. The extent of the valuable material may prove to be very limited, or, on the other hand, it may live down. The matter is speculative. The public who invest in mining enterprises would be well advised to insist on all prospectuses containing a report by some qualified mining engineer before risking their money on these reported high values, which may be purely a local occurrence. Many such engineers are available who are both qualified and reputable. The field warrants development, but this should be done by wise expenditure on actual mining operations and not bulling or bearing on the share market.

MELBOURNE.

July 13.

BROKEN HILL GEOLOGY.—The report of Mr. E. C. Andrews, New South Wales Government Geologist, on the geology of Broken Hill, has not yet been issued, but Mr. Andrews makes some interesting comments on the progress of his work in a statement printed in the Annual Report of the New South Wales Department of Mines for 1919, just published. He states that work has been seriously hampered by the prolonged strike, which has lasted since April, 1919, and is still unsettled. Most of the mines were flooded along their lower levels. Another cause of delay in the work is the unsafe nature of many stopes, after lying idle for months without repair. As the work of the survey progressed, it was noted that the structure was complicated in a greater degree than could have been foreseen upon a casual examination of the area. This complexity was due in part to the numerous and peculiar foldings and dislocations which had been developed within the rock masses, but it was due in the main to the obscuring of original sedimentary structures and mineral assemblages by the widespread but discontinuous intrusions of negligible size; by the very variable amount of alteration which the rocks had suffered from point to point along their strike or general direction; by the excessive thinness of the layers of sediment, such as clay, shale, or sand, which extended over the area at one period; by the original variation in character and texture of these beds traced along their strike; by the widespread cover of waste, and by the absence of notable natural exposure of rock such as occurs commonly in the valleys and gorges and on the peaks of mountain ranges such as the Alps, or even the Scottish Highlands.

A brief examination of the area had suggested that the rock masses consisted of myriads of sedimentary laminæ folded intimately, intruded and altered by numerous igneous bands conforming to the general trend of the sediments. It was noted later that large overthrust faults of the cross type existed between rock belts arranged sub-parallel to each other. The faults had crossed the combs, or the direction, of the country rocks in one place, but had passed at each end into faults or rock flowage arranged along the planes of the steep folds of the rock belts. Some of these faults are of considerable size, one, a little north-east of the Consols mine, exceeding half a mile in its throw, while another, which was recognized first by Mr. E. M. Holder, a member of the staff, exceeds 4,000 ft. in the amount of throw measured along the fault plane.

Much more difficult to detect is a series of heavy dislocations which conform, approximately, to the general trend of the rock belts. These appear to have arisen as the result of close and intense folding, with later gliding of one limb over another, thus giving a general semblance of conformable bedding. The dislocations appear to have been obscured still more by later folding of the fault planes. As a rule these heavy movements are not accompanied by wide zones of strong crushing, such as are associated with the cross-thrust planes. The latter may be set down tentatively as younger than the main sliding movements. The gliding, or sliding, of one fold over another has been inferred from the mapping of zones of sericite or silicious schist with eyes and lenses of quartz, against and in which certain belts of granulite, amphibolite, and schist disappear, without apparent repetition on the other side of any specified zone of strain. The lodes bear an intimate relationship to these zones of movement or strain.

The survey is far from complete. The results will be in the nature of a skeleton map, which will serve as a guide to future geologists. Problems as interesting, but as difficult as any which have ever faced the field geologists, are crowded thickly in this area, where dislocations of various types are in abundance, the whole being obscured by the ever-present mantle of waste, or of decomposing rock in situ, and by the intense alteration of sediments originally very similar to each other, thus baffling the survey up to the present in an attempt to trace the faulted, or flowage, blocks to their original positions. Only when the old anchorages of these now shattered fragments are indicated on the map may the work be said to have emerged from the qualitative to the quantitative stage.

THE BROKEN HILL STRIKE.—There is no better prospect of the strike at Broken Hill being settled than there was twelve months ago, unless indeed the report of the Health Commission, when published, should have some effect upon the issue, which is hardly likely. It is generally believed that this report will materially damage the claims made on the ground of the injurious effects of the industry, but the men on strike are not likely to be much affected by its disclosures, as the facts of the case are already well known to them. The Coal & Shale Workers' Federation, which has been bearing the burden of supporting the strikers, is apparently tiring of the very heavy drain upon it resources, and is moving in every direction to secure sympathy and relief from other quarters, not scrupling to besmirch Broken Hill generally as a lead-poisoned place, where the children are pale-faced and sickly, ill-developed, and destined to early graves. This announcement, made recently, was too much for the Broken Hill City Council, and at its first subsequent meeting, the city fathers (strongly "unionist" as they are) did not hesitate to unanimously disclaim the statement in every detail. One alderman after another strongly denounced the libel, declaring that the children of Broken Hill would compare favourably with those of any part of Australia. One of the aldermen declared that the only suggestion of lead about his children was that they are "lead-heavy" when he had to carry them. Other extravagant and damaging statements as to the prevalence of plumbism and miners' phthisis have been indignantly and scornfully denied by the local doctor who assisted in the Health Commission's investigation, and he declares that it would be too absurd to say that even 3% (as compared with the alleged 70%) of all the idle young men whom he saw daily in the reserves and streets were suffering from either phthisis or plumbism. They were well dressed, well fed, and generally smoking. They were prostituting the cause of true unionism, and living in idleness at the expense of starving miners' wives and children. But he draws a terrible picture of the straits to which formerly well-to-do families have been reduced by the barbarous cruelty of the strikers: "During the last few months it has been my lot to witness innumerable cases of hardship, famine, and distress. I have seen children with one garment, and barely that, running about back yards and picking up what garbage and scrap food they can find. The women themselves have been living on bread and jam and onions, and have long borne traces of starvation and neglect. I appeal to the sympathetic public to do something to stop this appalling condition of affairs. This strike has already extended beyond the term of endurance of nearly all the miners at Broken Hill. Hundreds have withdrawn all the money they had at the bank, and dozens have sold their homes. Many are dead through starvation and neglect. Surely the men can see that this cannot go on much longer." It would be useless, as well as manifestly unfair, to attempt to anticipate the contents of the report, but great interest is felt in the prospect of its speedy appearance. Another conference is about to be held in Sydney, to be presided over by Mr. J. B. Holme, who has been appointed a Special Commissioner under the New South Wales Industrial Arbitration Act.

It has been generally recognized from the first that the complaint of miners' disease produced in the mines was only an excuse for continuing the strike, and that the companies have done practically all that could be done to minimize the effects inseparable from the industry. The true objective of the strike leaders has now been declared officially, namely, the social ownership of the mines. "The miners," says the general secretary of the Australasian Coal & Shale Employees' Federation, "hold that the minerals in the earth belong to the general community, and should be owned by the general community." This, of course, is no great discovery. It has been acted upon ever since mining commenced, not only in Australia, but in practically all countries. The general community is continually being appealed to, on this very ground, to furnish the funds for getting out the minerals, and it is their own fault if miners as a body do not take a proportionate share of the risks and a proportionate share of the gains in such enterprises. A logical inference from any extension of the present system in a "social" direction would be that shareholders in unsuccessful companies, having invested in the "social" cause, should be recouped for their losses by the State, as the "social" representative. There would then be no difficulty in floating new ventures, and mining would enjoy halcyon days.

MOUNT CUTHBERT COPPER MINES.—Owing to delays in refining the company's products at the works of the Electrolytic Refining & Smelting Co., at Port Kembla (N.S.W.), the directors of this Queensland enterprise are temporarily under a financial cloud, and it has been necessary to shut down both the mines and the smelters. The delay at Port Kembla was the result of a strike there earlier in the year. There has also been inconvenience caused by the difficulty in marketing refined copper, already on hand, at profitable rates. The Commonwealth Bank had already made advances upon the output, and the E.R. & S. Co. had accommodated the Mount Cuthbert people by advancing money for current expenses. The present trouble arose when the bank refused to make further advances at the same rate. The bank, however, agreed with the refining company to jointly make an advance upon 360 tons of copper on hand; but at the half-yearly meeting on the 6th inst. the Chairman, Mr. P. Pigott, was able to announce that he hoped within a few days that sufficient funds would be available to enable them to dispense with this further assistance from the bank. There has never been any question of the value of the company's property, and the present embarrassment is entirely due to special circumstances. The directors have transferred £15,000 from their reserve to profit and loss account, and it is probable that a call of one shilling per share will be made, which will relieve the position, if not absolutely remove the embarrassment. Several months must elapse before returns from early shipments can be received in Australia, but it is hoped that by November things will be in ship-shape again. The company is working on good ore, and there is a promising development in the Orphan mine.

YETHOLME MOLYBDENITE.—The mining warden of the Bathurst district of New South Wales strongly advises the amalgamation of three molybdenite companies working there, and representatives of the managements of two of these concur in his suggestion. One of them stated in the warden's court recently that he had several times urged the same thing upon his directors, provided that the new company should not be over-capitalized. The warden said that a lot of money had been wasted and many grievous mistakes made. One company had too much plant and not sufficient ore; another had plenty of ore and insufficient plant. It would be better for all concerned if amalgamation were brought about; the companies would not then be under obligation to come to him repeatedly for exemption from labour conditions.

MINING EXPANSION IN TASMANIA.—The Tasmanian Public Works Committee has recommended the appropriation of £52,000 for the extension of the existing tramway between Zeehan and Comstock to Heemskirk in order to open up metalliferous country. The committee's inquiries were concerned with three distinct features: (1) Comstock silver-lead-zinc ores, (2) the Heemskirk tinfield, and (3) the iron deposits proposed to be mined by G. & C. Hoskins, of New South Wales. A new factor, the committee's report states, which entirely altered the aspect of the whole proposition, was the proposal of Messrs. Hoskins to work the iron deposits situated in the extreme west of the Comstock district. Large areas had been taken up by this firm, which proposed to rail the ore to Strahan, where bins were to be erected by the company. From Strahan the ore would be shipped to their smelters. As to the extent and value of the iron ore deposits, there did not seem any room for doubt. After discussing the proposal in its various aspects, the committee recommends the adoption of the Zeehan-Comstock route, the line to be standard gauge (3 ft. 6 in.) from Zeehan to the vicinity of the iron deposits at a cost of £34,760, provided a satisfactory agreement is entered into with Messrs. Hoskins, including reasonable guarantees as to bulk of ore to be handled, cost of freight, and the rights of other possible users. The committee cannot justify the extension of a standard gauge line to the Heemskirk district, but recommends the construction of a 2 ft. tramway from the terminus of the 3 ft. 6 in. line to Wakefield Creek, a distance of $4\frac{3}{4}$ miles, at an estimated cost of £17,500. In the event of the proposed agreement with Messrs. Hoskins failing to materialize, the committee recommends the extension of the Comstock tramway (2 ft.) from the summit to Pyke Creek, a distance of approximately $6\frac{3}{4}$ miles.

MOUNT BISCHOFF.—A demand was recently made by Mr. E. Skillern, organizer of the Australian Workers Union, for certain retrospective pay to the company's employees and for a general increase in wages. The claims were: That from December 1, 1919, to December 8, 1919, inclusive, retrospective pay at the rate of 1s. 6d. per day be paid, and from and including December 9, 1919, to date, retrospective pay at the rate of 6d. per day, and from the present date an increase of 6d. per shift all round, thus bringing the basic rate for the district to 11s. 6d. per day. Other conditions of work and contracts were not very favourable to the company. Intimation was also received that an answer must be given immediately, otherwise, in the words of the men's representative, "I will pull the men out and take them away to other districts." The directors refused the demands made, and work ceased. The men requested the Premier, Sir Walter Lee, to intervene, and at his request the directors agreed to confer with the men, but not with Mr. Skillern. This the men have declined to agree to, and they insist upon their bedrock demands. The smelters at Launceston are not affected, as ore from the East Coast is keeping them going. The miners at Waratah, however, refuse to allow ore to go from there, and it is being stored.

THE AUSTRALASIAN INSTITUTE.—Owing to the industrial position, the Council of the Australasian Institute of Mining and Metallurgy has found it necessary to postpone the meeting convened for August. Unless the position improves very shortly, the projected visits to the Port Pirie smelters and the Wallaroo & Moonta mines and works may not be practicable at all this year.

CAMBORNE.

GEEVOR.—For the four weeks ended August 11, 2,442 tons of ore was milled, which gave a recovery of $38\frac{1}{2}$ tons of black tin (or an average of 35·31 lb. per ton milled) and an estimated value of £5,900. The tonnage milled is still substantially below the figure anticipated when the new mill was installed, and, until this is improved, the profit earned will certainly not justify the increased capital. Working costs, including reasonable depreciation, must now be well over £2 per ton, so, presumably, on the estimated value of the monthly output, the profit at present is negligible. It is to be hoped that the new manager, Mr. F. C. Cann, will be able to speedily improve matters as regards the mill.

EAST POOL & AGAR.—At a time when developments were proving unusually interesting, it was most unfortunate that there should be a breakage of the balance-box at the 48 fm. level in Agar shaft, resulting in the flooding of the bottom workings. The water has not yet been forked sufficiently to permit of a complete stoppage of the Cornish pump for the purpose of getting the new half of the bob in position, but it is to be hoped that the work can be speedily completed before either the coal strike takes place or the winter rains commence, otherwise the matter will become very serious. It is quite evident that the electric pumps, which were installed in this shaft to supplement the Cornish pump, now provide no margin of safety, and this is probably accounted for by the increased water met with as a result of the intersection of the Great lode in the Tolgus tunnel. The company has notified the employees that, in the event of a coal strike, all operations will cease except pumping, as the reserve stock of coal is not sufficient to run any risks. How Tincroft will fare, seeing that the mine is run from hand to mouth in the matter of stores, remains to be seen.

KINGSDOWN (HEWAS WATER).—A recent progress report indicates that the main shaft has now been unwatered to a depth 203 ft. and sinking is proceeding. The Pit lode at a depth of 25 ft. has been driven on for a distance of 150 ft.; the lode is stated to be 2 ft. wide and shows "satisfactory results," whatever that may mean. This lode was passed through at 125 ft. from surface when sinking the main shaft, and 140 tons of ore brought to surface is reported by the manager to assay from 50 to 60 lb. tin oxide per ton. It is difficult to see the wisdom of driving on the lode at a depth of only 25 ft. from surface, but there may be some satisfactory explanation. In any case, however, the width and average assay-value should be given; it is not sufficient to record "satisfactory results." The company has now acquired a licence of the adjoining Ventonwyn mine, which was a small producer some 16 years ago.

LEVANT.—Another lamentable accident, on August 13 last, has to be recorded at this mine, this time four men being killed by an explosion at the 180 fm. level. The accident was due to an explosion of gelignite, but the cause cannot be ascertained. The four men killed were the only ones on the spot when the accident occurred, and as all were trammers, they had no occasion to handle gelignite, which appears to have been stored in tins on a ledge above where they were sitting at the time of the accident. If the gelignite was not handled by one of the men, either accidentally through the fall of a tin or out of curiosity, the explosion is presumably inexplicable. There is still much comment in Cornwall at the absence of information as to development at this mine and its equipment, for which the capital was provided at the commencement of the year. We can see no good reason for this unusual reticence, and the directors would be well advised to make public a statement setting out the progress made and the position of affairs generally. The project of a light railway from Penzance to St. Just via Newlyn and Sancreed has recently been revived, in view of the encouragement such schemes are being given by the Ministry of Transport. Such a railway would be of immense value to the St. Just mines, such as Levant, Geevor, and Boscaswell, as all stores have now to be hauled by steam tractor from Penzance, which adds appreciably to their cost.

THE MINING INDUSTRY ACT, 1920.—The grandiose scheme of the Government for the establishment of a special Ministry to control the coal and metal-mining industries of this country, to which reference has previously been made in these columns, has, owing to opposition in the House of Lords, been dropped, and in substitution there is to be established a Mines Department of the Board of Trade, to be supervised by one of the Parliamentary Secretaries of the Board, at a salary of £1,500 per annum. As the coal miners' unions decline to co-operate so far as the regulations concern the appointment of pit committees and their functions, the principal objective of the Act is defeated; as regards its effects on the metal-mining industry of this country, we can see little, if any, value, and certainly not sufficient to justify the inauguration of even a special department, for its powers are no greater than those afforded the various Departments which have hitherto been interested in the industry. The only good feature, from a metal-mining point of view, is the compulsory appointment of a committee to give the Department advice and assistance, and we hope the Cornish Chamber of Mines has already taken steps to be represented thereon, not necessarily by a capitalist, but by someone who has a real and close practical knowledge of the industry. Mr. W. C. Bridgeman, M.P., has been appointed the First Secretary of the new Department.

NATIONALIZATION.—The Joint Industrial Council of the Tin Mining Industry are to have under consideration at the next meeting the following recommendation, submitted by Mr. Dan Hillman, one of the representatives of the Dockers' Union:—"That the Joint Industrial Council, having heard the lengthy reply from Sir Robert Horne to the recent deputation, and understanding that there can be no financial assistance given to the industry on its present basis of management, therefore calls upon the Government to take over all the Cornish mines, nationalize all the minerals, and set up a Central Management Board, consisting of one half of the present mine managers and one half of tin miners and surface workers." To judge from the irresponsible rubbish talked by this labour agitator at a recent labour party meeting at Redruth, the Employers' Federation representatives will have no difficulty in meeting the arguments advanced in favour of this nationalization proposal. Nationalization of the minerals has much to commend it, but nationalization of the industry, involving Government control, why the mere thought of it to anyone who has suffered is sufficient!

TINCROFT.—For the six months ended June 30 last, a loss of £2,436 was made, and this compares with a deficiency of £3,424 for the previous half-year. This slightly improved result is due partly to an higher average price for black tin and to lessened development, which was about one-fifth of normal, or only one foot for every 30 tons milled. This latter is a most regrettable feature, but it is obvious that the strained financial condition of the company is responsible. Without vigorous development there can be no future for these mines, and with such a highly mineralized area for exploitation the present policy is most regrettable. It would surely be sound business for the owners of the minerals (Tehidy Minerals, Ltd.) to forgo royalties for a few years (with certain safeguards if profits were earned), provided the equivalent sum saved was spent by the company on development, and even to supplement such a grant by a secured loan for a similar purpose. Below is given a comparative statement showing the results for the last two half-yearly periods:

	Six months ended Dec 31, 1919	Six months ended June 30, 1920
Tonnage milled (tons)	15,849	16,931
Black tin recovered (tons)	144	136
Average recovery black tin (lb.)	20·30	18·00
Average price realized for black tin	£160	£196
Total receipts per ton milled	43s. 9·10d.	44s. 9·75d.
Total working cost per ton milled	40s. 0·95d.	47s. 8·27d.
Development footage	973 ft.	555 ft.
Persons employed, surface	282	201
Persons employed, underground	202	146

Development on Pryce's lode has proved very disappointing, and it is the South lode which appears to offer the best prospect of values above the general average of the mine. The intention of the management to sink Tyrie's shaft on this lode below the 224 fm. level has had to be deferred for reasons mentioned in previous months; this is most unfortunate, as the ore-shoot has been continuously good from the 180 to the 224 fm. level, and is going down strong in the sole of the level. The centralization of the dressing and concentration plant appears to have proved a profitable proposition; the outlay was approximately £4,500, and for the past 14 months there has been a saving of £300 per month.

PERSONAL.

A. F. S. ANDERSON is now with the Tongkah Harbour Tin Dredging Co., Siam.

DR. A. R. ANDREW has returned from Sarawak and New Zealand.

F. AVELINO ARAMAYO has been appointed Bolivian Minister in Paris.

J. H. BUTTERS, chief engineer for the Tasmanian State Hydro-Electric Department, is in London.

JOHN M. CAIRNS has returned from Spain, and has gone on a short visit to Norway.

J. E. CARNE, until recently New South Wales Government Geologist, has been presented with the Clarke memorial medal by the Royal Society of New South Wales.

H. H. CARROLL has been appointed underground manager at Broken Hill South mine.

E. A. LANGSLOW COCK, Chief Inspector of Mines, Nigeria, is here on leave.

JAMES COLQUHOUN has returned from the United States.

E. V. DABB and C. L. GREEN have left Camborne for the Federated Malay States.

G. A. DENNY is in Rhodesia.

STANLEY H. FORD has left for West Africa.

CHARLES H. FULTON has been appointed head of the mining engineering department at the Missouri School of Mines.

W. FURZE has left Camborne for Portugal.

DR. J. A. LEO HENDERSON has left for Canada and the United States.

JOSEPH JENNINGS has been appointed manager of New Abbott's mine, Barberton.

R. H. JOHNSON, of Laws, Rumbold & Co., has left for Northern Nigeria.

GEORGE A. LAIRD has left New York for South America for the Guiana Development Company.

G. F. LAYCOCK has gone to Newfoundland for the Anglo-Newfoundland Development Company.

V. F. STANLEY LOW has returned from Kelantan.

FRANK M. LUSH has left for Northern Nigeria.

E. P. MATHEWSON has been in Arizona since his return from Northern British Columbia.

E. T. MCCARTHY and HUMPHREY MORGANS are about to leave for Southern China.

HARVEY S. MUDD is here from the United States.

C. H. MUNRO expects to leave London for the Federated Malay States about the end of this month.

RUNDLE OLDS is leaving for South Africa.

PHILIP PLUMMER, lately at Port Pirie, is now smelting superintendent for the Burma Corporation at Namtu.

W. A. POPE has returned from Northern Nigeria.

S. R. PRISK and R. H. HAYDON have gone to Lobitos, Peru.

R. P. ROBERTS, chief metallurgist to the Mount Lyell company, is visiting the United States.

W. ROBERTSON has been appointed consulting engineer to the Broken Hill Associated Smelters, and is succeeded as general manager by H. St. J. Somerset.

E. W. SKEATS, professor of geology in Melbourne University, has obtained a year's leave of absence in order to take an extensive trip abroad.

J. W. H. STUBBS has returned from Algeria.

L. A. E. SWINNEY has received an appointment as Inspector of Mines in the Federated Malay States.

DR. GRIFFITH TAYLOR has been appointed Professor of Geography in the University of Sydney.

A. R. THOMSON, manager of the Wankie Colliery, has returned to Rhodesia.

DR. ARTHUR WADE is expected from Papua.

ERIC E. WATSON has gone to Burma.

HARRY WESLEY, metallurgist at the Chillagoe smelting works, has resigned to start an independent practice at Sydney.

BURR WHEELER has been appointed general manager for the Chile Copper Co., at Chuquicamata, in succession to H. C. BELLINGER, who has been appointed vice-president with headquarters at New York.

HAROLD YATES has been appointed lecturer in geology, mineralogy, and petrology in the Ballarat School of Mines.

A. R. PENGILLY, S. V. GRIFFITH, R. COOKSEY, J. W. PEDDER, E. ROBSON, J. S. PENBERTHY, J. ANGOVE, J. ROBERTS, W. DEMPSTER, P. BISHOP, W. BROWN, and B. POE, who have just completed their courses at Camborne Mining School, have accepted appointments under the Guggenheims and have gone to Bolivia.

J. GEORGE LEYNER died in Colorado on August 5 in his 60th year. He was the inventor of the rock-drill known by his name, and more recently he devoted his attention to the development of the agricultural tractor.

JOHN TAYLOR died on August 24, at the age of 78. He was the third of his name, the first, his grandfather, being the founder of the firm of John Taylor & Sons, more than a century and a quarter ago. He joined the firm in 1871 and retired in 1903. He will always be remembered for his pluck in the early days of the Kolar goldfield, when the first results of prospecting and development were disappointing. Had it not been for his truly miner-like decision to have another shot, the riches of the Mysore gold mine and its neighbours might never have been disclosed.

TRADE PARAGRAPHS

PRICE'S COMPANY, LTD., of Battersea, London, S.W.11, send us a pamphlet on Diesel and semi-Diesel oil engines, dealing particularly with their lubrication.

MR. T. L. REED COOPER, of 11, Tothill Street, Westminster, is introducing a new type of submersible centrifugal pump and electric motor combined.

THE DE LAVAL STEAM TURBINE CO., Premier House, Southampton Row, London, W.C., are introducing the Zeta centrifugal pumps in this country.

GWYNNES, LTD., of Hammersmith Iron Works, London, W.6, have issued a pamphlet dealing with modern centrifugal pumping machinery, including mine and sinking pumps.

FRASER & CHALMERS ENGINEERING WORKS (Proprietors, the General Electric Co., Ltd.), of Erith, Kent, send us a new catalogue describing their steam turbines, turbo-blowers, and turbo-compressors. The catalogue is divided into two parts, Nos. 13 and 13A.

THE HUMPHREY PUMP COMPANY has disposed of its patent rights in the Humphrey pump to WILLIAM BEARDMORE & CO., LTD., of Glasgow. This pump, in which water is lifted by gas-explosion, was described in the Magazine for January, 1910.

THE MYERS-WHALEY CO., of Knoxville, Tennessee, send us particulars of their drift shovel, which is intended for use in small tunnels and drifts. The company's agent in this country is Mr. F. A. Perry, 63, Queen Victoria Street, London, E.C.

R. WHITE & SONS, of the Ditton Engineering Works, Widnes, send us two new pamphlets, one of them dealing with automatic tipping wagons and other similar tipping devices in connection with the transport of ore, and the other with automatic ash-handling plant.

CENTRIFUGAL SEPARATORS, LTD., 8, Iddesleigh House, Westminster, send us pamphlets describing the Gee centrifugal filter, in particular giving details of a plant erected at the International Paint & Composition Co.'s works near Newcastle-on-Tyne. Some notes as to the design of the Gee machine are given in the Mining Digest this month.

THE HARDINGE COMPANY, of New York, Denver, and London, are extending the application of their conical mill in many industries other than metal mining, cement grinding and coal pulverization providing two recent new applications. The company reports also another large repeat order for mills from the Nevada Consolidated Copper Company.

In this column last month it was stated that AGRICULTURAL and GENERAL ENGINEERS, LTD., had made arrangements to purchase the control of HENRY BESSEMER & CO., LTD. It transpires, however, that not sufficient of the shareholders in the latter company offered to sell out, so that the scheme has lapsed, at any rate in its present form.

EDGAR ALLEN & CO., LTD., of the Imperial Steel Works, Sheffield, write to a contemporary in connection with pioneer work in electric steel furnaces, saying that the first Heroult furnace installed in this country was erected at their works in 1909. It is interesting to note also that the Tropenas converter process was developed at their works, and that by its means steel castings for dynamo magnets and electric motors were first produced successfully.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO., of Pittsburgh, U.S.A., send us the following particulars of a mine locomotive headlight with spring suspended case. In order to withstand the severe conditions under which they are used, these have been designed so that the incandescent lamp case is carried on a spring suspension which adequately protects the filament from breakage due to vibration and jars. The case, which contains the socket and lamp, is entirely suspended from six springs. These springs are arranged symmetrically and are in tension. Thus the spring suspension is equally effective in all directions, assuring the longest possible lamp-life. This type of suspension is much superior to the usual type employing helical springs in compression. The new headlight responds to the slightest pressure in any direction, assuring perfect cushioning, while the usual type requires a considerable force to be exerted in any direction before any movement takes place, which means that only partial cushioning is obtained. The frame, case, and cover of the headlight are made of high-grade cast-iron, heavy enough to withstand a great deal of abuse. As the lens-holder is fitted to the case with a threaded joint and rubber gaskets, the headlight is tightly sealed and is, therefore, suitable for use in gaseous mines. Where the headlights are to be operated on circuits of more than 250 volts a resistance is supplied. This resistance is housed in a full cast-iron case of sturdy construction, which is superior to the sheet-steel housing usually furnished.

THE GENERAL ELECTRIC CO., LTD., of 67, Queen Victoria Street, London, E.C., have sent us a copy of the fifth reprint of the twelfth edition of the X & Y section of their catalogue, dealing with low and medium Tension Switchgear. Considerable alterations and additions have been made, with the result that the catalogue section is even more comprehensive than hitherto, thereby adding materially to its value as a well arranged and indexed compendium of switches, cut-outs, and accessories for circuits up to 600 volts. The usual features are retained, and being divided in the main into two parts—Open Type Gear and Ironclad Gear, with each part again subdivided into groups for easy reference—the catalogue will prove invaluable to electrical engineers, consulting engineers, contractors, and all those connected with the installation and upkeep of electrical plant, lighting systems, and apparatus generally.—"Peel," "Witton," "Adelphi," and "Leader" Main Switches are listed as hitherto, and additional sizes and designs added. Besides Battery Switches, Main and Shunt Resistance Switches, Field Breaking Switches, Volt and Ammeter Switches of the more usual types, a new design of Three-phase Ammeter Switch makes its appearance.—The pages next following are devoted to Main Cut-outs—"Bobbin," "Handguard," "Wedge," and "Open" types—and Cable Connectors, Sweating Sockets, etc.—In the Ironclad Gear Section a number of new sizes have been added to the range of "Salford" Main Switches, including 75, 150, 300 and 400 ampere switches and switches with fuses. The "Twin-break" switches are now listed also in triple pole, with and without fuses. The newest designs of "D.B." (double break) switches and switches with fuses are shown, the stirrup-handle arrangement affording a most effective interlocking device.—Following a useful range of explosion-proof switches, for use in fiery mines and other industrial situations where an explosive atmosphere may be present, we come to crane limit switches, and switches with interlocked plugs for factory and dockyard use. For the first time space is devoted to the "Unit" system of "Salford" Switches—the system which has proved so advantageous in factories and workshops for the control of motors, power and lighting circuits, etc., on account of its compactness, neatness, and ease of effecting extensions. In brief, the system enables a complete dust and damp proof unit to be built up from suitable standard attachments, such as bus-bar chambers, ammeter attachments, cable boxes and "Salford" switches with the utmost economy in wiring, space, and labour of erection. It complies in all respects with the Home Office Factory Regulations, and may be mounted on angle-iron framework or pedestals as desired.—The Distribution Fuse Boards illustrated command attention, each board consisting of one, two, or three enamelled slate slabs, according to the number of poles, with insulating barriers between. The fuses are of the G.E.C. Handguard pattern, and to comply with the Home Office Factory Regulations insulating shields are provided, which entirely cover up and make it impossible for the operator accidentally to come in contact with any live metal on the front of the fuse panels. Bus-bars and branch terminals are fitted with the necessary sweating sockets. The enclosing case is of cast iron, with solid or glazed front, and is rendered weatherproof by means of a tallowed-hemp gasket, fitted into a groove all round the joints between the lid and the box. The lid is secured by hinged wing nuts ensuring even pressure all round the joint. Standard boards are supplied with plain holes, which, to facilitate wiring, are drilled as nearly as possible directly opposite the sweating sockets and are fitted with wood bushes, but special drilling can be arranged to suit customers' requirements, and watertight and special glands for armoured cable can be supplied. For three-phase distribution the "Stepped" type of fuse-board possesses great advantages as will be gathered from the following description: "These boards are similarly equipped to the distribution boards just described, but to meet the difficulty experienced in connecting up, especially if there are many ways on one board, each phase is arranged on a different level, that is, at different distances from the back of the case. Thus the cables for one set of fuses can be brought in at one level and for the other sets at different levels. All confusion in wiring is thereby avoided. The case is of cast iron or sheet steel, and the cable inlets are plain holes, wood bushed, arranged at the top of the board, in the most convenient positions for the inlet and outlet cables. Special drilling can be arranged to suit customers' requirements. Watertight and special glands for armoured cable can also be supplied."—The final section is devoted to house service cut-outs, sealing troughs, fuses for house service cut-outs, switch and cut-out sets of the G.E.C. tried and proved designs, and to explosion-proof cut-outs.—Nine pages of dimension drawings complete the publication.

METAL MARKETS

COPPER.—The market during the past month has on the whole displayed quite a firm tone, the improvement being more marked, however, in the case of standard than in the case of refined. This is not surprising in view of the very wide margin which still exists between these two grades of the metal. Indeed it is rather astonishing that prices of standard copper have not approached even more nearly to the value of refined, as quite a good demand has been seen recently for rough copper. This inquiry emanated for the most part from Italy, who required the metal for sulphate-making, and from America, who presumably found that the price of copper was sufficiently attractive to induce them to buy here, and take the metal over to the United States for refining. In view of the business referred to, it looks as if the stocks of rough copper in this country would soon show a considerable diminution. This, however, may not be noticeable for a month or two, as the sales do not all call for prompt delivery. In regard to refined metal there is little change in the position. The adverse rate of dollar exchange keeps prices up here, but so far as actual business doing is concerned there is little improvement. There has, however, been some little inquiry from Germany for wire-bars and from Belgium for ingot-bars. It is interesting to note that at the same time Germany was a seller of forward-delivery cathodes, these being, it is understood, refined from scrap. In regard to the situation in the United States, the present position does not seem too satisfactory. Values are called steady at about 19 cents, but this seems to be a very nominal price, and is quoted as the market level for the reason apparently that the chief producers who sell through the Export Association ask for that figure for overseas business. At the same time there are other sellers at 18½ cents, if not less. So far as the business with domestic consumers is concerned, this does not seem to have improved very much. No doubt the unsatisfactory traffic conditions in the United States are partly responsible, but it looks as if orders for manufactured material were not quite so pressing, indeed cancellations are reported, and although the brass mills in Connecticut are understood to have got most of their men back again, they do not seem to have done much buying. It is understood that the Canadian production of copper according to preliminary official returns fell from 59,384 tons (of 2,000 lb.) in 1918, which was the highest on record, to 37,562 tons in 1919, which was the smallest since 1911. Of the figures mentioned 27,160 tons were contained in blister copper and in matte produced in Canada, part of which was refined at Trail and part at Port Colborne. The balance was exported for refining, and as well 10,402 tons were estimated as recovered from ores sent to the United States smelters. The production of refined copper in Canada last year was 3,487 tons (of 2,000 lb.), against 3,809 tons in 1918.

Average prices of cash standard copper: August 1920, £94. 1s.; July 1920, £90. 5s. 6d.; August 1919, £97. 11s. 4d.; July 1919, £99. 14s. 5d.

TIN.—During the past month the tin market has fluctuated a good deal, but such movements were within a narrower range than is often the case with this metal. For a time there was rather a lack of any very definite tendency, but latterly prices have drifted lower on the labour situation. It was generally considered that the position of the metal intrinsically was by no means bad, inasmuch as the big stocks which at one time were in existence at various producing points had to a large extent been dispersed, and the market was therefore on a sounder basis. On the other hand it cannot be said that the demand has been good. Home consumers have had various difficulties to contend with, such as transport dislocation, while also the demand for tin-plates has not been particularly brisk. At the same time the threatened coal strike cast a shadow over the position, and naturally consumers were disinclined to open up further commitments. Again the business doing with America has not been particularly brisk here. The United States seem to have done a fair amount of buying in the Straits Settlements, but in the aggregate such purchases are not up to what might have been expected. From time to time it has been reported that consumers in America were taking more interest, but this did not result in much business reaching this side. Again the political situation in Europe has also for a while cast a shadow over the market, and induced operators to go cautiously. Meanwhile Straits tin and also Australian tin on spot fetch good premiums somewhere around £8 per ton, while even London

DAILY LONDON METAL PRICES: OFFICIAL CLOSING
Copper, Lead, Zinc, and Tin per Long

	COPPER				
	Standard Cash	Standard (3 mos.)	Electrolytic Ingots	Electrolytic Wire-Bars	Best Selected
August	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
11	93 10 0 to 93 15 0	95 10 0 to 95 15 0	112 0 0 to 117 0 0	115 0 0 to 117 0 0	108 0 0 to 109 0 0
12	93 5 0 to 93 10 0	95 5 0 to 95 10 0	112 0 0 to 117 0 0	115 0 0 to 117 0 0	108 0 0 to 109 0 0
13	94 10 0 to 94 15 0	96 5 0 to 96 10 0	112 0 0 to 116 0 0	115 0 0 to 116 0 0	104 0 0 to 106 0 0
16	94 0 0 to 94 5 0	95 15 0 to 96 0 0	111 0 0 to 116 0 0	114 0 0 to 116 0 0	104 0 0 to 106 0 0
17	93 5 0 to 93 10 0	95 0 0 to 95 5 0	111 0 0 to 117 0 0	114 0 0 to 117 0 0	105 0 0 to 106 0 0
18	93 17 6 to 94 2 6	95 10 0 to 95 15 0	111 0 0 to 117 0 0	114 0 0 to 117 0 0	105 0 0 to 106 0 0
19	93 10 0 to 93 15 0	95 0 0 to 95 5 0	111 0 0 to 117 0 0	114 0 0 to 117 0 0	105 0 0 to 106 0 0
20	93 10 0 to 93 15 0	95 5 0 to 95 10 0	111 0 0 to 118 0 0	115 0 0 to 118 0 0	105 0 0 to 107 0 0
23	94 0 0 to 94 5 0	95 10 0 to 95 15 0	111 0 0 to 118 0 0	116 0 0 to 118 0 0	105 0 0 to 107 0 0
24	94 5 0 to 94 10 0	95 10 0 to 95 15 0	111 0 0 to 118 0 0	116 0 0 to 118 0 0	105 0 0 to 107 0 0
25	94 5 0 to 94 10 0	95 15 0 to 96 0 0	111 0 0 to 117 0 0	116 0 0 to 117 0 0	105 0 0 to 107 0 0
26	93 15 0 to 94 0 0	95 5 0 to 95 10 0	111 0 0 to 117 0 0	116 0 0 to 117 0 0	105 0 0 to 107 0 0
27	94 5 0 to 94 10 0	95 15 0 to 96 0 0	111 0 0 to 117 0 0	115 0 0 to 117 0 0	105 0 0 to 107 0 0
30	94 15 0 to 94 17 6	96 0 0 to 96 5 0	111 0 0 to 117 0 0	116 0 0 to 117 0 0	105 0 0 to 107 0 0
31	95 0 0 to 95 5 0	96 5 0 to 96 10 0	111 0 0 to 117 0 0	116 0 0 to 117 0 0	105 0 0 to 107 0 0
Sept.					
1	95 0 0 to 95 2 6	96 5 0 to 96 7 6	111 0 0 to 117 0 0	116 0 0 to 117 0 0	105 0 0 to 107 0 0
2	95 2 6 to 95 7 6	96 7 6 to 96 12 6	111 0 0 to 117 0 0	116 0 0 to 117 0 0	105 0 0 to 107 0 0
3	95 15 0 to 96 0 0	97 0 0 to 97 5 0	111 0 0 to 117 0 0	116 0 0 to 117 0 0	106 0 0 to 107 0 0
6	95 5 0 to 95 10 0	96 5 0 to 96 10 0	111 0 0 to 117 0 0	116 0 0 to 117 0 0	106 0 0 to 107 0 0
7	95 0 0 to 95 5 0	96 0 0 to 96 5 0	111 0 0 to 117 0 0	116 0 0 to 117 0 0	106 0 0 to 107 0 0
8	96 10 0 to 96 15 0	97 5 0 to 97 10 0	111 0 0 to 117 0 0	116 0 0 to 117 0 0	106 0 0 to 107 0 0
9	97 5 0 to 97 10 0	97 10 0 to 97 15 0	112 0 0 to 118 0 0	117 0 0 to 118 0 0	106 0 0 to 107 0 0

Banka fetches a premium of a couple of pounds or so. The Banka production during July is reported at 1,134 tons, compared with 961 tons in June and 823 tons in July of last year. This makes the total for the seven months 7,286 tons, compared with 5,719 tons a year ago. Apart from the Straits the business doing with other Eastern producing countries has not been very brisk. Of course, China has either withheld offers or quoted very high prices as a result of the higher prices which rule for silver. In regard to Batavia, holders there also want full prices, and in some quarters there is a feeling that some kind of arrangement has been come to with certain of the Batavian and Singapore interests with the object of keeping prices up. This is, however, more or less rumour, and nothing definite seems to be known on the subject here.

Average prices of cash standard tin: August 1920, £274. 5s. 10d.; July 1920, £262. 1s. 6d.; August 1919, £271. 8s.; July 1919, £253. 5s. 1d.

LEAD.—The chief feature of this market during the past month has been considerable buying which has been seen here for account of America. Quite a considerable business has been done, amounting to, it is believed, something like 12,000 tons, but in spite of this, values have declined on balance during the period under review. The fact is that business with home consumers and for export to other European countries is very slow, and apparently there was still a considerable amount of metal probably held on speculative account which had to be liquidated, so that the purchasing mentioned by America has probably simply prevented prices declining as they might otherwise have done in the period of slack trade here, and with the labour outlook none too satisfactory. Meanwhile Germany has been exporting some lead, arrivals having been reported here from time to time. There seem to be at least prospects of an early resumption of work at Broken Hill. It was announced late in the month that the conference in Australia between representatives of the mining companies and the Unions, presided over by Judge Edmunds, to whose decision both sides are bound, completed its consideration of all matters excepting combating for one item which was to be taken on September 7. Until that date the conference stood adjourned, but in the meantime it was stated that the Judge would give his decision of all other claims, and as soon as these were published it was expected that work would be resumed at Broken Hill. This announcement had very little effect on prices on the Metal Exchange.

Average prices of lead: August 1920, £36. 8s. 10d.; July 1920, £35. 9s.; August 1919, £25. 1s. 7d.; July 1919, £23. 14s. 2d.

SPELTER.—This metal has tended downward during the month of August, the market being on the whole very dull. The demand from home consumers seems to have gradually tapered off, and during the period under review has been very quiet. Indeed, rather than open up new commitments, consumers were more disposed to re-sell some of their holdings or ask for the postponement of deliveries. Consequently there was little support to keep the market from slipping back. Meanwhile offers of considerable quantities of spelter were experienced here both from Germany and of German spelter through Norwegian sources. These offers were quite at the parity of the market here, and some business was done, but latterly Norway seems to have got a little firmer in her ideas, although Germany, it is understood, is still a seller. Obviously, the adverse rate of exchange under which Germany suffers when purchasing from other countries must be of considerable assistance to her when she comes to sell for export, that is to say, so long as the material from which she is producing the spelter is already in the country and does not have to be purchased outside. The American market in the meantime has continued very steady, and well above the parity of values here. Under these circumstances it can naturally have been supposed that buyers in the United States would have been tempted to pick up some metal in this country, but although it could have been purchased for shipment from here c.i.f. New York at prices below New York quotations, very little business seems to have come off. According to figures compiled by Mr. C. E. Siebenthal, of the United States Geological Survey, from reports admitted by all zinc smelters, during the first six months of 1920 the production of zinc from domestic ores was 251,065 tons, and from foreign ores 7,043 tons, a total of 258,108 tons, compared with 210,241 tons in the last half of 1919, and 255,502 tons

PRICES ON THE LONDON METAL EXCHANGE.
Tons; Silver per Standard Ounce; Gold per Fine Ounce.

Lead: Soft Foreign	Lead: English	Zinc (Spelter)	Standard Tin: Cash	Standard Tin: 3 mos.	Silver: Cash	Silver: Forward	Gold	
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.			s. d.	August
36 10 0 to 36 10 0	40 0 0	42 5 0 to 43 15 0	276 10 0 to 277 0 0	283 10 0 to 284 0 0	58⅜	58⅝	113 0	11
36 0 0 to 36 5 0	39 0 0	41 15 0 to 43 5 0	276 10 0 to 277 0 0	283 10 0 to 284 0 0	58¾	58⅞	111 11	12
35 5 0 to 35 15 0	38 0 0	41 10 0 to 43 0 0	276 15 0 to 277 0 0	283 10 0 to 284 0 0	59¼	59	112 11	13
35 7 6 to 36 0 0	38 0 0	41 0 0 to 42 10 0	274 10 0 to 274 15 0	282 0 0 to 282 5 0	59⅜	59⅜	113 3	16
35 17 6 to 36 7 6	38 10 0	41 15 0 to 43 10 0	274 15 0 to 275 0 0	281 15 0 to 282 0 0	59¾	60	114 0	17
35 10 0 to 36 0 0	38 10 0	41 5 0 to 42 15 0	274 10 0 to 275 0 0	281 10 0 to 282 0 0	60½	60¼	114 0	18
35 10 0 to 36 0 0	38 10 0	41 0 0 to 42 10 0	275 5 0 to 275 15 0	282 0 0 to 282 10 0	61	61	114 7	19
35 15 0 to 36 5 0	38 10 0	41 2 6 to 42 12 6	270 10 0 to 271 0 0	278 0 0 to 278 10 0	63¾	63¾	115 0	20
35 17 6 to 36 5 0	38 10 0	40 15 0 to 42 5 0	267 10 0 to 268 0 0	274 0 0 to 274 10 0	60⅞	60⅞	115 3	23
35 17 6 to 36 5 0	38 10 0	40 5 0 to 41 15 0	262 15 0 to 263 5 0	269 5 0 to 269 10 0	60⅞	60⅞	115 6	24
35 15 0 to 36 0 0	38 10 0	40 0 0 to 41 10 0	262 10 0 to 263 0 0	269 10 0 to 270 0 0	61	61	116 0	25
35 15 0 to 35 17 6	38 0 0	39 15 0 to 41 5 0	269 10 0 to 270 0 0	278 0 0 to 278 10 0	61⅛	61	115 0	26
35 17 6 to 36 0 0	38 0 0	40 0 0 to 41 10 0	274 15 0 to 275 0 0	282 0 0 to 282 15 0	61	60⅞	115 0	27
36 10 0 to 36 15 0	38 10 0	40 0 0 to 41 10 0	273 0 0 to 273 10 0	281 10 0 to 282 0 0	59⅝	59½	115 5	30
36 12 6 to 36 15 0	38 10 0	39 10 0 to 41 0 0	272 0 0 to 272 10 0	279 0 0 to 279 10 0	58¾	58½	115 6	31
								Sept.
36 10 0 to 36 10 0	38 10 0	39 5 0 to 40 10 0	269 10 0 to 270 0 0	276 0 0 to 276 10 0	57⅝	57¼	115 1	1
36 10 0 to 36 10 0	38 10 0	38 10 0 to 40 0 0	269 0 0 to 269 10 0	276 0 0 to 276 10 0	58½	58⅛	115 1	2
36 10 0 to 36 12 6	38 10 0	37 15 0 to 39 5 0	267 0 0 to 267 10 0	274 10 0 to 275 0 0	59	58¾	115 3	3
36 5 0 to 36 5 0	38 10 0	38 5 0 to 39 15 0	266 0 0 to 266 10 0	272 10 0 to 273 0 0	60⅜	60	115 6	6
35 10 0 to 35 10 0	37 10 0	38 5 0 to 39 15 0	264 10 0 to 265 0 0	270 10 0 to 270 15 0	59½	59⅛	115 6	7
36 5 0 to 36 0 0	38 0 0	38 15 0 to 40 5 0	266 0 0 to 266 5 0	272 15 0 to 273 5 0	59	58⅝	115 11	8
35 15 0 to 35 10 0	37 15 0	39 0 0 to 40 5 0	267 0 0 to 267 10 0	273 15 0 to 274 0 0	58½	58⅛	115 9	9

in the first half. The stocks held at smelters on June 30 were 29,892 tons, these figures showing an increase from 36,795 tons at the end of 1919, and 59,651 tons at the middle of 1919.

Average prices of spelter: August 1920, £41. 19s. 6d.; July 1920, £42. 13s. 4d.; August 1919, £39. 16s. 9d.; July 1919, £42. 3s. 10d.

ZINC DUST.—The price of high-grade Australian zinc dust continues at £85 per ton with prompt supplies scarce.

ANTIMONY.—The price of English regulus has been reduced to £52 per ton for ordinary quality and £55 for special brands. As regards foreign regulus, the price stands at around £46 to £49 for spot material according to quantity.

ARSENIC.—Only a very small business is passing and Cornish white is quoted at about £72 to £75 per ton delivered London or Liverpool.

BISMUTH.—There is no change to be reported in the price, which continues at 12s. 6d. per lb. with a moderate demand.

CADMIUM.—The market is quiet, and the quotation has been at about 6s. 6d. per lb.

ALUMINIUM.—There is no change to be reported, the price for home trade continuing at £165, while for export £185 is quoted.

NICKEL.—The price remains at £230 either for home business or for export.

COBALT METAL.—The price has undergone a sharp rise, and is now quoted at 30s. per lb.

COBALT OXIDE.—The price of black oxide has gone up to 20s. per lb.

PLATINUM.—The price has advanced, the quotation being about £31 per oz. nominal.

PALLADIUM.—The price is nominal at around £30 per oz.

QUICKSILVER.—This market has been weakened by Continental offers of Italian material, and about the end of August the chief producers of Spanish reduced their price sharply, with the result that the quotation is about of £18 to £19 per bottle.

SELENIUM.—10s. 6d. to 13s. per lb.

TELLURIUM.—Nominal at 90s. to 95s. per lb.

SULPHATE OF COPPER.—There has been little business moving and the price has remained at about £44 for early delivery; for forward delivery higher figures are asked, but it is doubtful if any business is moving thereat.

MANGANESE ORES.—The market has been quiet, the quotation for both Caucasian and Indian standing at about 4s. c.i.f. per unit.

TUNGSTEN ORES.—The market has been rather easy, and the quotation for wolframite 65% stands at around 26s. per unit.

SILVER.—The market showed an upward tendency, prices reaching 63¾d. for spot standard bars on August 20. Subsequently the tone became easier, and at the end of the month the prices of spot stood at 58¾d.

GRAPHITE.—There is little change in this market. The price of soft velvety flake 85 to 90% stands at around £60 to £80 per ton. In regard to Madagascar, 82 to 85%, the price is about £25 c.i.f.

MOLYBDENITE.—The quotation for 85% is more or less nominal at about 75s. to 80s. c.i.f. U.K.

CHROME ORES.—The quotation is about £8 to £8. 5s. c.i.f. U.K. for 50% ores.

IRON AND STEEL.—The chief feature during the month of August was the announcement of a rise of 7s. 6d. per ton in the price of Cleveland pig iron, this to take effect from September 1. This was of course to compensate for the increased railway freights and raw material. The price for No. 1 Cleveland from September 1 onward is therefore 237s. 6d., and for No. 3 G.M.B. 225s. As the home demand is still sufficient to use up all the supply no prices have been made for export. In regard to hematite, the price was not advanced when the railway rates were put up owing to the fact that the freights on foreign ore declined, and offset other advances. The price of East Coast mixed numbers therefore stands at 260s. for the home trade and 265s. for export. In regard to manufactured iron and steel, this market has been somewhat overshadowed by the prospects of the coal strike, as if the strike came off business naturally would be to all intents and purposes suspended, while the trade might have experienced additional losses through cancellations of orders, not to mention the diversion of orders to other countries. Signs are not wanting that competition on the part of America and Belgium is a factor to be reckoned with.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Par Value
	Oz.	Oz.	Oz.	£
May, 1919	706,158	18,837	724,995	3,079,583
June	682,603	19,776	702,379	2,983,515
July	705,523	19,974	725,497	3,081,713
August	686,717	19,952	706,669	3,001,739
September	680,359	18,199	698,558	2,967,287
October	705,313	18,409	723,722	3,074,174
November	657,845	20,125	677,920	2,879,834
December	631,833	18,358	650,191	2,761,836
Year 1919	8,111,271	218,820	8,330,091	35,383,974
January 1920	653,295	17,208	670,503	*
February	607,918	17,412	625,330	*
March	689,645	17,391	707,036	*
April	667,926	19,053	686,979	*
May	681,551	17,490	699,041	*
June	699,199	16,758	715,957	*
July	718,521	17,578	736,099	*

* Not given in the official returns.

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
May 31, 1919	173,376	12,232	5,939	191,547
June 30	172,505	12,544	5,831	190,880
July 31	173,613	12,453	5,736	191,802
August 31	170,844	12,450	5,655	188,949
September 30	169,120	12,392	5,294	186,806
October 31	167,499	12,691	4,492	184,682
November 30	164,671	12,565	4,337	181,573
December 31	166,155	12,750	4,271	183,176
January 31, 1920	176,390	12,766	4,796	193,952
February 29	185,185	12,708	5,217	203,110
March 31	188,564	12,788	5,232	206,584
April 30	189,446	12,951	5,057	207,454
May 31	184,722	12,897	4,793	202,412
June 30	179,827	13,036	4,596	197,459
July 31	174,187	13,005	4,521	191,713

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 65% of the working profit. Figures for yield and profit for 1919 based on par value of gold; subsequently gold premium included.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
June, 1919	2,032,169	28 4	22 4	5 10	592,361
July	2,134,668	27 10	21 9	6 0	611,118
August	2,036,128	28 5	22 11	5 5	551,203
September	2,019,109	28 6	22 10	5 7	560,979
October	2,108,698	28 3	22 6	5 10	612,841
November	1,933,526	28 8	23 5	5 5	521,472
December	1,845,088	28 8	25 6	3 10	354,098
Year 1919	24,043,638	28 7	22 11	5 6	6,605,509
January, 1920	2,038,092	34 4	24 2	10 2	1,036,859
February	1,869,180	35 1	28 3*	6 10*	644,571*
March	2,188,104	31 8	25 2	6 6	716,610
April	2,065,446	31 5	26 3	5 2	533,940
May	2,117,725	31 9	25 11	5 10	618,147
June	2,146,890	31 10	25 2	6 8	69[illegible],510

* Results affected by the back-pay disbursed in accordance with new wages agreement.

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1919	1920	1919	1920
	£	oz.	£	
January	211,917	43,428	104,063	
February	220,885	44,237	112,616	
March	225,808	45,779	112,543	
April	213,160	47,000	109,570	
May	218,057	46,266	100,827	No official returns published.
June	214,215	45,054	106,612	
July	214,919	46,208	102,467	
August	207,339	—	103,112	
September	223,719	—	100,401	
October	204,184	—	91,352	
November	186,462	—	9[illegible],322	
December	158,835	—	9[illegible],806	
Total	2,499,498	317,972	1,[illegible]691	

Transvaal Gold Outputs.

	June.		July.	
	Treated	Yield	Treated	Yield
	Tons	Oz.	Tons	Oz.
Aurora West	10,400	£13,942	10,750	£14,916
Brakpan	49,500	19,687	52,800	21,792
City Deep	86,000	33,867	90,600	36,753
Cons. Langlaagte	45,000	£66,628	47,200	£68,313
Cons. Main Reef	51,100	18,754	52,500	18,433
Crown Mines	190,000	58,570	200,000	61,789
Durban Roodepoort Deep	24,100	7,372	26,000	8,348
East Rand P.M.	128,000	35,690	140,000	36,121
Ferreira Deep	33,300	10,257	34,300	11,505
Geduld	43,000	15,222	45,000	15,626
Geldenhuis Deep	47,600	13,521	51,400	13,921
Glynn's Lydenburg	3,482	£5,537	3,868	£7,834
Goch	16,000	£16,489	14,700	£17,656
Government G.M. Areas	130,000	£259,338	139,000	£287,265
Kleinfontein	44,040	13,221	49,160	14,812
Knight Central	26,200	7,899	28,200	7,965
Knights Deep	90,000	16,746	98,300	16,873
Langlaagte Estate	41,350	£70,050	43,500	£71,465
Luipaard's Vlei	19,000	£25,566	19,430	£24,587
Meyer & Charlton	14,050	£47,137	14,560	£45,678
Modderfontein	84,000	43,335	89,000	45,215
Modderfontein B	51,500	26,101	56,000	28,226
Modderfontein Deep	42,400	22,147	44,400	23,370
Modderfontein East	21,000	£3,300†	24,000	7,618
New Unified	11,100	£14,722	11,700	£15,574
Nourse	42,800	14,060	45,300	14,147
Primrose	20,500	£21,054	21,500	£22,194
Princess Estate	—	2,580	—	765
Randfontein Central	151,000	£196,556	157,000	£194,674
Robinson	40,000	9,562	41,400	8,935
Robinson Deep	57,100	18,687	58,600	18,824
Roodepoort United	24,000	£24,666	25,100	£27,805
Rose Deep	58,700	15,540	60,400	15,682
Simmer & Jack	60,100	14,174	61,600	£77,064
Springs	34,700	16,464	42,000	18,813
Sub Nigel	10,700	6,432	10,500	34,032
Transvaal G.M. Estates	14,590	£26,253	17,980	£30,172
Van Ryn	36,800	£42,132	36,950	£46,423
Van Ryn Deep	50,200	£127,114	53,800	£142,687
Village Deep	44,800	15,324	52,700	15,839
Village Main Reef	16,300	5,162	15,800	4,951
West Rand Consolidated	31,800	£43,356	34,000	£48,509
Witwatersrand (Knights)	35,200	£50,904	38,400	£55,610
Witwatersrand Deep	30,850	7,867	33,000	8 938
Wolhuter	32,000	8,621	34,000	9,043

† Profit.

West African Gold Outputs.

	June.		July.	
	Treated	Value	Treated	Value
	Tons	Oz.	Tons	Oz.
Abbontiakoon	7,898	£14,680	8,736	£14,884
Abosso	6,060	2,337	3,780	1,557
Akoko	—	—	202	171
Ashanti Goldfields	6,424	7,288	3,332	4,465
Obbuassi	625	397	—	—
Prestea Block A	7,638	£16,372	8,872	£14,743
Taquah	—	£7,449	3,220	1,781

Rhodesian Gold Outputs.

	June.		July.	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Falcon	15,390	28,451*	16,003	38,184*
Gaika	3,375	5,881	3,786	5,923
Globe & Phœnix	6,207	7,916†	5,862	8,076†
London & Rhodesian	2,290	3,030	2,535	2,862
Lonely Reef	4,820	5,348†	4,920	4,866†
Planet-Arcturus	—	—	3,641	5,879
Rezende	5,500	2,474†	5,550	2,475†
Rhodesia, Ltd.	735	286	792	293
Rhodesia, G.M. & I.	607	352	613	217
Shamva	50,550	40,695	51,900	42,813
Transvaal & Rhodesian	—	—	1,550	5,617

* Gold, Silver and Copper; † Ounces Gold.

West Australian Gold Statistics.—Par Values.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
June, 1919	1,050	73,546	74,596	316,862
July	680	68,028	68,708	292,852
August	835	58,117	58,952	250,410
September	†	†	†	†
October	586	64,987	65,573	278,535
November	1,171	64,823	65,994	280,323
December	831	27,334	28,165	162,575
January, 1920	836	25,670	26,506	112,590
February	1,928	49,453	51,381	218,251
March	*nil*	54,020	54,020	229,461
April	835	56,256	57,091	242,506
May	227	50,976	51,203	217,495
June	502	56,679	57,181	242,638
July	—	48,341	48,341	205,340
August	167	54,258	54,425	231,185

† Figures not received.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1919	1920	1919	1920	1919	1920
	£	Oz.	£	Oz.	£	£
January	36,238	7,105	37,100	4,724	18,000	28,000
February	46,955	8,677	43,330	7,200	24,000	15,000
March	40,267	24,126	48,000	6,973	16,000	22,000
April	63,818	6,368	61,200	8,368	24,000	12,000
May	37,456	13,263	38,200	8,432	16,000	13,800
June	41,465	15,707	44,600	13,725	17,000	8,700
July	37,395	—	42,060	—	22,000	17,410
August	51,564	—	49,700	—	20,000	—
September	76,340	—	37,120	—	13,000	—
October	39,018	—	36,100	—	28,000	—
November	40,735	—	32,720	—	51,000	—
December	63,311	—	44,500	—	31,000	—
Total	575,260	75,246	514,630	49,422	280,000	116,910

Australasian Gold Outputs.

	June.		July.	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Associated	5,605	7,698	6,084	9,366
Blackwater	2,128	3,967	1,672	3,428
Bullfinch	6,250	1,871‡	6,140	2,150‡
Golden Horseshoe	11,664	4,894‡	11,952	4,889‡
Great Boulder Prop.	8,243	23,855	9,498	27,975
Ivanhoe	14,004	4,269‡	13,950	4,880‡
Kalgurli	4,515	7,723	4,239	5,426
Lake View & Star	10,148	11,804	9,926	11,069
Menzies Consolidated	1,540	3,065	1,600	2,593
Oroya Links	1,320	8,428†	1,263	11,910†
Progress	1,250	1,161	880	1,279
Sons of Gwalia	10,864	15,067	11,120	15,919
South Kalgurli	8,040	3,213‡	8,185	2,689‡
Waihi	12,948	4,278‡	13,443	3,909‡
Waihi Grand Junction	5,890	1,881‡	5,800	1,879‡
Yuanmi	—	—	1,944	4,734

† Including royalties ; ‡ Oz.

Miscellaneous Gold Outputs.—Par Values.

	June.		July.	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
El Oro (Mexico)	30,500	224,000†	33,500	246,000†
Esperanza (Mexico)	24,876	3,550§	22,629	3,154§
Frontino & Bolivia (C'lbia)	2,710	11,090	2,550	9,487
Mexico El Oro (Mexico)	11,850	196,290†	11,850	222,030†
Oriental Cons. (Korea)	—	80,000†	—	66,000†
Ouro Preto (Brazil)	7,400	2,599‖	6,900	2,472‖
PlymouthCons.(Calif'rnia)	6,650	9,606	7,800	9,596
St. John del Rey (Brazil)	—	35,000	—	36,000
Santa Gertrudis (Mexico)	28,010	20,390‡	25,120	17,580‡

§ Loss. † Dollars. ‡ Profit, gold and silver. ‖ Oz.

Production of Gold in India.

	1916	1917	1918	1919	1920
	oz.	oz.	oz.	oz.	oz.
January	45,214	44,718	41,420	38,184	39,073
February	43,121	42,566	40,787	36,834	38,872
March	43,702	44,617	41,719	38,317	38,760
April	44,797	43,726	41,504	38,248	37,307
May	45,055	42,901	40,889	38,608	38,191
June	44,842	42,924	41,264	38,359	37,864
July	45,146	42,273	40,229	38,549	37,129
August	45,361	42,591	40,496	37,850	37,375
September	45,255	43,207	40,088	36,813	—
October	45,061	43,041	39,472	37,138	—
November	45,247	42,915	36,984	39,628	—
December	48,276	44,883	40,149	42,643	—
Total	541,077	520,362	485,236	461,171	304,571

Indian Gold Outputs.

	July.		August.	
	Tons Treated	Fine Ounces	Tons Treated	Fine Ounces
Balaghat	3,150	2,363	3,300	2,363
Champion Reef	12,514	6,010	12,503	6,404
Mysore	20,432	13,133	20,120	13,193
North Anantapur	800	966	800	962
Nundydroog	8,646	6,235	8,736	6,004
Ooregum	12,800	8,422	12,900	8,449

Base Metal Outputs.

		June.	July.
Arizona Copper	Short tons copper	1,500	1,500
British Broken Hill	Tons lead conc.	—	—
	Tons zinc conc.	—	—
	Tons carbonate ore	—	—
Broken Hill Block 10	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Burma Corp.	Tons refined lead	2,113	1,525
	Oz. refined silver	265,620	190,070
Fremantle Trading	Long tons lead	—	—
Hampden Cloncurry	Tons copper	572	581
North Broken Hill	Tons lead	—	—
	Oz. silver	—	—
Poderosa	Tons copper ore	443	410
Rhodesian Broken Hill	Tons lead	1,210	1,283
Tanganyika	Long tons copper	1,961	2,558
Tolima	Tons silver-lead conc	45	47
Zinc Corp.	Tons zinc conc.	—	—
	Tons lead conc.	—	—

Imports of Ores, Metals, etc., into United Kingdom.

		July.	August.
Iron Ore	Tons	641,975	606,696
Manganese Ore	Tons	46,523	50,574
Copper and Iron Pyrites	Tons	32,518	67,751
Copper Ore, Matte, and Precipitate	Tons	1,309	859
Copper Metal	Tons	15,502	11,038
Tin Concentrate	Tons	2,740	2,037
Tin Metal	Tons	2,061	1,950
Lead, Pig and Sheet	Tons	12,587	14,767
Zinc (Spelter)	Tons	13,417	5,170
Quicksilver	Lb.	410,642	17,735
Zinc Oxide	Tons	864	469
White Lead	Cwt.	19,314	28,413
Barytes	Cwt.	53,649	71,197
Phosphate	Tons	22 568	19,194
Sulphur	Tons	154	22
Borax	Cwt.	—	177
Other Boron Compounds	Tons	1,998	1,138
Nitrate of Soda	Cwt.	97,085	183,516
Nitrate of Potash	Cwt.	11,222	14,308
Petroleum:			
Crude	Gallons	21,366	2234
Lamp Oils	Gallons	18,160,629	8,025,227
Motor Spirit	Gallons	23,263,746	16,800,791
Lubricating Oils	Gallons	4,677,932	5,539,977
Gas Oil	Gallons	4,415,913	5,208,452
Fuel Oil	Gallons	27,321,460	44,689,070
Total Petroleum	Gallons	77,873,046	80,272,808

OUTPUTS OF TIN MINING COMPANIES.
In Tons of Concentrate.

	May Tons	June Tons	July Tons
Nigeria:			
Associated Nigerian	20	20	20
Benue	–	–	–
Bisichi	5	6	15
Bongwelli	1	1	1
Dua	2	1½	3
Ex-Lands	25	30	35
Filani	3	5	6
Forum River	8	7	8
Gold Coast Consolidated	2¼	3¾	4½
Gurum River	13	14	14
Jantar	8	6	6
Jos	8½	9¼	13¼
Kaduna	8½	6¼	9¼
Kaduna Prospectors	5	6¾	7
Kano	4	5¼	3¾
Kuru	9	10	14
Kwall	7	6	–
Lower Bisichi	5¾	6	8¾
Lucky Chance	1½	1	1¾
Minna	1¾	2½	3¼
Mongu	35	34	30
Naraguta	25	35	46
Naraguta Extended	14	20	25
Nigerian Consolidated	8½	9	17
Ninghi	6	4½	4
N.N. Bauchi	40	38	37½
Offin River	20¼	15½	9
Rayfield	40	35	35
Ropp	36	72	78
Rukuba	4	2	4¾
South Bukeru	6	6	7
Sybu	2	2½	2¼
Tin Fields	4	10	11½
Yarde Kerri	4	4½	4
Federated Malay States:			
Chenderiang	–	78½*	–
Gopeng	60	60	60
Idris Hydraulic	26¾	22½	19⅓
Ipoh	14	11	11
Kamunting	–	88*	–
Kinta	41¾	41¾	30
Lahat	35¾	41⅔	44⅔
Malayan Tin	44½	65½	60
Pahang	215	215½	217½
Rambutan	15	18	15
Sungei Besi	30	31	31
Tekka	31	30	30
Tekka-Taiping	36	36	36
Tronoh	37	27	27
Cornwall:			
East Pool	72½	80	95½
Geevor	36	36	38½
Grenville	34¾	35¾	21
South Crofty	54	52½	51¾
Other Countries:			
Aramayo Francke (Bolivia)	160	140	133
Berenguela (Bolivia)	32	28	33
Briseis (Tasmania)	25	20	20
Deebook (Siam)	22	14	–
Mawchi (Burma)	105	82	84
Porco (Bolivia)	14	19	10
Renong (Siam)	46½	28½	43½
Rooiberg Minerals (Transvaal)	24	50½	45
Siamese Tin (Siam)	87½	71½	73½
Tongkah Harbour (Siam)	88	94	75
Zaaiplaats (Transvaal)	25	28	28

† Two months. * Three months.

NIGERIAN TIN PRODUCTION.
In long tons of concentrate of unspecified content.
Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1915	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons	Tons
January	417	531	667	678	613	547
February	358	528	646	668	623	477
March	418	547	655	707	606	505
April	444	486	555	584	546	467
May	357	536	509	525	483	383
June	373	510	473	492	484	435
July	455	506	479	545	481	484
August	438	498	551	571	616	—
September	442	535	538	520	561	—
October	511	584	578	491	625	—
November	467	679	621	472	536	—
December	533	654	655	518	511	—
Total	5,213	6,594	6,927	6,771	6,685	3,298

PRODUCTION OF TIN IN FEDERATED MALAY STATES.
Estimated at 70% of Concentrate shipped to Smelters. Long Tons.

	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons
January	4,316	3,558	3,149	3,765	4,265
February	3,372	2,755	3,191	2,673	3,014
March	3,696	3,286	2,608	2,819	2,770
April	3,177	3,251	3,308	2,855	2,606
May	3,729	3,413	3,332	3,404	2,741
June	3,435	3,489	2,950	2,873	2,940
July	3,517	3,253	3,373	3,756	2,824
August	3,732	3,413	3,259	2,955	2,786
September	3,636	3,154	3,166	3,161	—
October	3,681	3,436	2,870	3,221	—
November	3,635	3,300	3,131	2,972	—
December	3,945	3,525	3,023	2,413	—
	43,871	39,833	37,370	36,867	23,946

TOTAL SALES OF TIN CONCENTRATE AT REDRUTH TICKETINGS

	Long tons	Value	Average
August 25, 1919	130½	£18,297	£140 4 3
September 8	115½	£16,588	£143 12 6
September 22	135½	£19,557	£144 6 9
October 8	72	£10,867	£150 18 7
October 20	32	£5,093	£159 3 2
November 3	34½	£5,235	£151 15 0
November 17	39	£6,161	£157 19 9
December 1	38	£5,905	£155 8 3
December 15	29	£5,133	£176 10 0
December 31	14¾	£2,884	£195 10 10
Total and Average, 1919	2,858	£366,569	£128 5 0
January 12, 1920	31	£6,243	£201 8 0
January 26	51¾	£10,574	£204 6 10
February 9	37½	£7,880	£210 2 8
February 23	53¾	£12,120	£225 10 0
March 8	18	£4,038	£224 7 7
March 22	44	£8,286	£188 6 8
April 6	44½	£8.367	£188 0 5
April 19	33½	£6,375	£190 6 0
May 3	61½	£11,641	£1·9 5 9
May 17	44	£6.151	£139 16 0
May 31	10	£1,578	£157 16 0
June 14	24¾	£3,278	£132 9 3
June 28	14½	£1,932	£133 4 10
July 12	43¾	£6.133	£140 4 0
July 26	10½	£1,643	£156 10 0
August 9	10½	£1,664	£158 10 0
August 23	27¼	£4,022	£147 12 0

DETAILS OF REDRUTH TIN TICKETINGS.

	August 9		August 23	
	Tons	Realized	Tons	Realized
		£ s. d.		£ s. d.
Tincroft Mines,	10½	158 10 0	5	152 0 0
"	—	—	5½	152 2 6
Penryn Minerals	—	—	15¾	144 0 0
"	—	—	1	157 12 6
Total	10½	—	27¼	—

Stocks of Tin

Reported by A. Strauss & Co. Long Tons.

	June 30.	July 31.
	Tons	Tons
Straits and Australian Spot	347	853
Ditto, Landing and in Transit	730	155
Other Standard, Spot and Landing	4,882	3,525
Straits, Afloat	900	1,250
Australian, Afloat	207	169
Banca, in Holland	413	1,160
Ditto, Afloat	800	1,323
Billiton, Spot	—	—
Billiton, Afloat	—	145
Straits, Spot in Holland and Hamburg	—	—
Ditto, Afloat to Continent	301	60
Total Afloat for United States	6,717	7,916
Stock in America	3,586	1,926
Total	18,883	18,482

Shipments, Imports, Supply, and Consumption of Tin.

Reported by A. Strauss & Co. Long tons.

	June	July
Shipments from:	Tons	Tons
Straits to U.K.	750	1,275
Straits to America	3,210	2,555
Straits to Continent	301	35
Straits to Other Places	289	152
Australia to U.K.	150	250
U.K. to America	1,217	1,244
Imports of Bolivian Tin into Europe	1,993	—
Supply:		
Straits	4,261	3,865
Australian	150	250
Billiton	—	145
Banca	914	1,470
Standard	1,498	1,614
Total	6,823	7,344
Consumption:		
U.K. Deliveries	1,691	1,939
Dutch ,,	—	—
American ,,	6,500	5,530
Straits, Banca & Billiton, Continental Ports, etc.	550	276
Total	8,741	7,745

Dividends Declared by Mining Companies.

Date	Company	Par Value of Shares	Amount of Dividend
Aug. 31	Broken Hill Block 14	Pref. 6s.	5% less tax
Sept. 6	Chenderiang Tin Dg.	£1.	2s. tax free
Sept. 6	Globe and Phœnix	5s.	1s. less tax
Aug. 13	Kinta Tin	£1.	2s. tax free
Sept. 1	Lahat	£1.	1s. less tax
Sept. 3	Malayan Tin Dredging	£1.	1s. less tax
Aug. 30	Mexico Mines of El Oro	£1.	4s. tax free.
Aug. 30	Mining Corporation of Canada	$5	12½ cents less tax
Sept. 9	Mysore Gold Mining	10s.	9d. on fully paid and 6¾d. on 7s. 6d. paid, both less tax
Sept. 9	North Anantapur Gold Mines	Pref. £1.	6d. + 1s. bonus, less tax
		Ord. £1.	6d. + 1s. bonus, less tax
Sept. 8	Nundydroog	10s.	6d. less tax
Aug. 26	Oroville Dredging	£1.	9d. less tax
Aug. 26	Pato Mines (Col'bia)	£1.	7s. less tax
Aug. 24	Tekka-Taiping	£1.	3d. on fully paid and ¾d. on 5s. paid, less tax
Sept. 9	Tongkah Harbour Tin Dredging	£1.	2s.
Aug. 17	Witbank Colliery	£1.	2s.

PRICES OF CHEMICALS. September 10.

These quotations are not absolute; they vary according to quantities required and contracts running.

		£	s.	d.
Alum	per ton	20	0	0
Alumina, Sulphate of	,,	17	0	0
Ammonia, Anhydrous	per lb.		2	6
,, 0·880 solution	per ton	38	10	0
,, Carbonate	per lb.			7½
,, Chloride of, grey	per ton	60	0	0
,, ,, ,, pure	per cwt.	5	5	0
,, Nitrate of	per ton	70	0	0
,, Phosphate of	,,	120	0	0
,, Sulphate of	,,	23	10	0
Antimony Sulphide, Golden	per lb.		1	6
Arsenic, White	per ton	76	0	0
Barium Sulphate	,,	12	0	0
Bisulphate of Carbon	,,	60	0	0
Bleaching Powder, 35% Cl.	,,	26	0	0
Borax	,,	41	0	0
Copper, Sulphate of	,,	42	0	0
Cyanide of Sodium, 100%	per lb.		1	0
Hydrofluoric Acid	,,			7½
Iodine	,,		16	0
Iron, Sulphate of	per ton	4	0	0
Lead, Acetate of, white	,,	80	0	0
,, Nitrate of	,,	62	0	0
,, Oxide of, Litharge	,,	55	0	0
,, White	,,	63	0	0
Lime, Acetate, brown	,,	20	0	0
,, ,, grey 80%	,,	33	0	0
Magnesite, Calcined	,,	25	0	0
Magnesium, Chloride	,,	17	0	0
,, Sulphate	,,	13	0	0
Methylated Spirit 64° Industrial	per gal.		8	0
Phosphoric Acid	per lb.		1	9
Potassium Bichromate	per lb.		2	0
,, Carbonate 85%	per ton	105	0	0
,, Chlorate	per lb.		0	11
,, Chloride 80%	per ton	40	0	0
,, Hydrate (Caustic) 90%	,,	120	0	0
,, Nitrate	,,	66	0	0
,, Permanganate	per lb.		4	0
,, Prussiate, Yellow	,,		2	0
,, Sulphate, 90%	per ton	45	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	52	0	0
,, Arsenate 45%	,,	60	0	0
,, Bicarbonate	,,	9	0	0
,, Bichromate	per lb.		1	6
,, Carbonate (Soda Ash)	per ton	15	0	0
,, ,, (Crystals)	,,	5	10	0
,, Chlorate	per lb.			5½
,, Hydrate, 76%	per ton	32	0	0
,, Hyposulphite	,,	31	0	0
,, Nitrate, 95%	,,	24	0	0
,, Phosphate	,,	44	0	0
,, Prussiate	per lb.		1	2
,, Silicate	per ton	11	0	0
,, Sulphate (Salt-cake)	,,	8	0	0
,, ,, (Glauber's Salts)	,,	10	0	0
,, Sulphide	,,	55	0	0
Sulphur, Roll	,,	19	0	0
,, Flowers	,,	19	0	0
Sulphuric Acid, Non-Arsenical, 140°T.	,,	5	0	0
,, ,, ,, 90%	,,	7	5	3
,, ,, ,, 96%	,,	9	7	6
Superphosphate of Lime, 18%	,,	5	0	0
Tartaric Acid	per lb.		3	0
Zinc Chloride	per ton	27	0	0
Zinc Sulphate	,,	22	10	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Sept. 12 1919 £ s. d.	Sept. 7 1920 £ s. d.
RAND:		
Brakpan	3 11 3	2 12 6
Central Mining (£8)	9 11 3	8 12 6
City & Suburban (£4)	8 9	7 6
City Deep	3 0 0	2 17 0
Consolidated Gold Fields	1 18 9	1 9 3
Consolidated Langlaagte	19 6	17 6
Consolidated Main Reef	13 9	14 6
Consolidated Mines Selection (10s.)	1 6 6	1 2 6
Crown Mines (10s.)	2 13 9	2 13 9
Daggafontein	1 6 0	11 0
Durban Roodepoort Deep	7 6	5 9
East Rand Proprietary	6 3	8 9
Ferreira Deep	11 0	10 0
Geduld	2 15 0	1 18 0
Geldenhuis Deep	10 9	7 6
Gov't Gold Mining Areas	4 17 6	4 5 6
Heriot	11 3	6 0
Johannesburg Consolidated	1 10 9	1 9 0
Jupiter	4 6	2 0
Kleinfontein	12 6	7 3
Knight Central	6 3	4 6
Knights Deep	8 3	6 6
Langlaagte Estate	19 0	16 6
Meyer & Charlton	4 8 9	4 12 6
Modderfontein (10s.)	28 5 0*	3 13 3
Modderfontein B	8 16 3	6 16 3
Modder Deep (5s.)	8 15 0†	2 4 3
Modder East	—	1 2 6
New State Areas	—	1 10 0
Nourse	14 9	10 0
Rand Mines (5s.)	3 3 9	2 19 3
Rand Selection Corporation	3 16 3	2 12 6
Randfontein Central	15 6	12 6
Robinson (£5)	10 0	7 0
Robinson Deep A (1s.)	1 0 0	17 6
Rose Deep	17 6	17 0
Simmer & Jack	5 0	3 9
Simmer Deep	2 6	6
Springs	2 18 9	2 2 0
Sub-Nigel	1 5 0	17 6
Union Corporation (12s. 6d.)	1 0 6	17 3
Van Ryn	18 3	17 0
Van Ryn Deep	3 16 3	3 17 6
Village Deep	15 0	10 3
Village Main Reef	12 6	5 0
West Springs	—	17 6
Witwatersrand (Knight's)	1 0 6	14 3
Witwatersrand Deep	12 0	8 6
Wolhuter	3 9	4 6
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	18 9	13 9
Transvaal Gold Mining Estates	13 9	10 0
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	25 7 6	19 5 0
Jagersfontein	6 8 9	4 15 0
Premier Deferred (2s. 6d.)	9 10 0	10 0 0
RHODESIA:		
Cam & Motor	5 6	12 0
Chartered British South Africa	1 1 9	15 9
Falcon	13 6	8 6
Gaika	15 6	14 6
Globe & Phœnix (5s.)	1 1 0	17 0
Lonely Reef	2 15 0	2 16 3
Rezende	5 2 6	3 0 0
Shamva	1 18 9	1 16 3
Willoughby's (10s.)	6 6	6 0
WEST AFRICA:		
Abbontiakoon (10s.)	4 9	2 9
Abosso	12 0	10 6
Ashanti (4s.)	1 2 9	17 0
Prestea Block A	5 9	2 6
Taquah	16 0	13 9
WEST AUSTRALIA:		
Associated Gold Mines	3 6	3 0
Associated Northern Blocks	3 6	3 0
Bullfinch	2 6	3 6
Golden Horse-Shoe (£5)	1 10 0	15 0
Great Boulder Proprietary (2s.)	10 0	7 3
Great Fingall (10s).	1 9	1 6
Hampton Properties	—	11 3
Ivanhoe (£5)	2 3 9	18 9
Kalgurli	9 6	15 0
Lake View Investment (10s.)	1 [illegible] 6	16 6
Sons of Gwalia	5 6	6 0
South Kalgurli (10s.)	5 6	6 0

GOLD, SILVER, *cont.*	Sept. 12 1919 £ s. d.	Sept. 7 1920 £ s. d.
OTHERS IN AUSTRALASIA:		
Blackwater, New Zealand	8 9	8 9
Consolidated G.F. of New Zealand	2 6	3 9
Mount Boppy, N.S.W. (10s.)	0 9	5 0
Progress, New Zealand	1 9	1 9
Talisman, New Zealand	8 9	6 6
Waihi, New Zealand	2 5 0	1 13 9
Waihi Grand Junction, New Z'lnd	14 3	10 0
AMERICA:		
Buena Tierra, Mexico	18 3	10 0
Camp Bird, Colorado	1 5 6	13 3
El Oro, Mexico	1 1 9	13 6
Esperanza, Mexico	1 0 3	14 3
Frontino & Bolivia, Colombia	9 3	10 0
Le Roi No. 2 (£5), British Columbia	11 3	5 0
Mexico Mines of El Oro, Mexico	7 7 6	6 17 6
Nechi (Pref. 10s.), Colombia	12 6	9 3
Oroville Dredging, Colombia	1 10 6	1 2 6
Plymouth Consolidated, California	1 7 0	10 0
St. John del Rey, Brazil	18 6	15 6
Santa Gertrudis, Mexico	1 15 6	1 3 6
Tomboy, Colorado	18 0	8 9
RUSSIA:		
Lena Goldfields	1 7 6	17 6
Orsk Priority	—	10 0
INDIA:		
Balaghat (10s.)	6 0	8 6
Champion Reef (2s. 6d.)	4 3	2 9
Mysore (10s.)	1 15 0	17 0
North Anantapur	5 0	3 3
Nundydroog (10s.)	14 6	10 6
Ooregum (10s.)	16 6	13 6
COPPER:		
Arizona Copper (5s.), Arizona	2 0 0	2 10 0
Cape Copper (£2), Cape and India	2 12 6	1 2 6
Esperanza, Spain	5 9	5 0
Hampden Cloncurry, Queensland	17 6	15 0
Mason & Barry, Portugal	2 3 9	1 10 0
Messina (5s.), Transvaal	5 0	5 6
Mount Elliott (£5), Queensland	3 15 0	1 5 0
Mount Lyell, Tasmania	1 4 0	1 3 0
Mount Morgan, Queensland	1 5 6	18 3
Mount Oxide, Queensland	7 0	3 9
Namaqua (£2), Cape Province	1 15 0	1 10 0
Rio Tinto (£5), Spain	54 0 0	32 10 0
Russo-Asiatic Consd., Russia	—	9 6
Sissert, Russia	1 2 6	11 3
Spassky, Russia	1 10 0	17 6
Tanganyika, Congo and Rhodesia	4 13 9	1 15 0
LEAD-ZINC:		
BROKEN HILL:		
Amalgamated Zinc	1 6 0	1 8 9
British Broken Hill	2 1 3	2 0 0
Broken Hill Proprietary (8s.)	2 5 9	3 3 9
Broken Hill Block 10 (£10)	1 5 0	1 2 6
Broken Hill North	2 12 6	2 11 3
Broken Hill South	2 2 6	2 10 0
Sulphide Corporation (15s.)	1 1 6	17 0
Zinc Corporation (10s.)	1 2 0	18 0
ASIA:		
Burma Corporation	9 13 9	9 17 6
Russian Mining	17 6	10 0
RHODESIA:		
Rhodesia Broken Hill (5s.)	12 9	11 0
TIN:		
Aramayo Francke, Bolivia	4 0 0	3 0 0
Bisichi, Nigeria	14 0	10 6
Briseis, Tasmania	4 6	4 3
Dolcoath, Cornwall	10 6	3 3
East Pool (5s.) Cornwall	19 6	10 0
Ex-Lands Nigeria (2s.), Nigeria	3 0	3 0
Geevor (10s.) Cornwall	1 3 3	10 0
Gopeng, Malay	2 1 3	1 15 0
Ipoh Dredging, Malay	1 0 6	17 6
Kamunting, Malaya	2 6 3	2 10 0
Kinta, Malaya	2 12 6	2 2 6
Malayan Tin Dredging, Malay	2 5 0	1 17 6
Mongu (10s.), Nigeria	1 0 0	17 0
Naraguta, Nigeria	17 6	10 0
N. N. Bauchi, Nigeria (10s.)	8 3	5 0
Pahang Consolidated (5s.), Malay.	16 0	11 3
Rayfield, Nigeria	17 0	8 0
Renong Dredging, Siam	2 8 9	2 0 0
Ropp (4s.), Nigeria	1 1 6	8 6
Siamese Tin, Siam	3 7 6	3 1 3
South Crofty (5s.), Cornwall	13 9	12 3
Tehidy Minerals, Cornwall	1 2 6‡	15 0
Tekka, Malay	4 5 0	1 3 9§
Tekka-Taiping Malay	5 7 6	1 5 0§
Tronoh, Malay	2 3 9	1 15 0

* £4 shares split into 8 of 10s. each. † £1 shares split into 4 of 5s. each. ‡ 15s. paid up. § New shares.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

ARRHENIUS AND HIS WORK.

The Franklin Institute presented its medal to Svante Arrhenius, the great Swedish physicist, at a meeting held on May 19. We quote herewith the address delivered by Dr. H. F. Keller in presenting the medal.

Dr. Keller, in making the presentation, said: The name of Svante Arrhenius is commonly associated with one of the greatest and most fruitful generalizations in the entire domain of chemistry, the theory of electrolytic dissociation; but it is by no means this wonderful achievement alone that the Institute desires to recognize by the bestowal of its highest award upon the Swedish scientist, but rather the vast sum of constructive endeavour by which he has extended and illumined our knowledge of the physical universe.

Svante Arrhenius was born at Castle Wijk, near Upsala, Sweden, on February 19, 1859. His father was the manager of the Wijk estate and also of the adjoining University properties. His ancestors were farmers in Smaland, in southern Sweden, where both of Svante's parents were born. It was from the name of the old Smaland homestead, Arena, meaning river bank, that the latinized family name, Arrhenius, was derived. Shortly after Svante's birth the father removed to Upsala to assume entire charge of the University's extended estates, and it was in this ancient town that the boy received his early education. In 1876 he was graduated from the Cathedral School, the youngest member of his class and near the head of it. His work in mathematics and the sciences was particularly brilliant. After entering the university he made such rapid strides in his studies that he succeeded in passing the examinations for the degree of "candidate" at the end of the third semester. As his major subject he chose chemistry under Cleve's direction, but at the same time he zealously pursued mathematical studies, and in 1881 he decided to become a physicist. Not satisfied with the limited facilities of the Upsala laboratory, he went to Stockholm, where he worked under Edlund's direction, acquiring in rapid succession the degrees of "Licentiate" and of Doctor of Physics. His first original investigation was on the subject of voltaic polarization, and this was followed by "Researches on the Conductivity of Electrolytes," which he presented as his dissertation for the Doctorate, and which has since become a classic in the annals of exact science. In the same year, 1884, he published as a continuation to this paper the "Chemical Theory of Electrolytes." The two publications, though not entirely free from doubtful or debatable opinions, are most remarkable for the wealth of novel and fundamentally important ideas advanced in them. Particularly striking at that time was the suggestion that the affinity co-efficients of acids and bases should be proportional to their electrical conductivities, a prediction which it was impossible then to support by experimental data. But this Law of Arrhenius was shortly afterwards verified by Ostwald at Riga. In Sweden the results and views of Arrhenius were received with scepticism, bordering on contempt, but fortunately their true value was promptly recognized by leading scientists in other countries and particularly by Ostwald. This helped to overcome the prejudices of the Swedish chemists and physicists, and presently Arrhenius was permitted to "habilitate" himself as Dozent at Upsala, and a little later he was granted an ample stipend by the Swedish Academy, enabling him to make an extended tour to the leading seats of physical research in various countries. While at Leipzig, in 1887, he conceived the Theory of Electrolytic Dissociation, his *magnum opus*, in which the main ideas of his former publications are crystallized into one comprehensive and definite generalization. The way for a favourable reception of this achievement had in the meantime been prepared by the researches of Kohlrausch on the phenomena of electrolytic conduction, those of van't Hoff on osmotic pressure, and by Raoult's work on the depression of the freezing point of liquids by a substance dissolved in them. All these and others might be named that contributed materials for Arrhenius' theory.

The fertility of this ionic theory, as it came to be called, can hardly be over-estimated; it is indeed without a parallel in physical science. For more than a decade after its announcement it prompted and directed innumerable researches, in the course of which many well-known, but hitherto unexplained, phenomena were quantitatively elucidated. Among the subjects thus investigated may be mentioned the application of the theory to the law of mass action and its effect on the equilibria of the ions, culminating in the discovery of the law of dilution; a masterly study of the problem of chemical equilibrium of electrolytes; and also applications of the theory to such questions as the action of the voltaic pile, the analytical chemical reactions, the solubility of gases, and many others.

It should be stated also that soon after its publication Arrhenius' theory was successfully applied in the study and development of industrial, chemical, and metallurgical processes. To it may be traced in a large measure the rapid progress that has been made during the past 25 years in many branches of applied chemistry, including some of the basic industries.

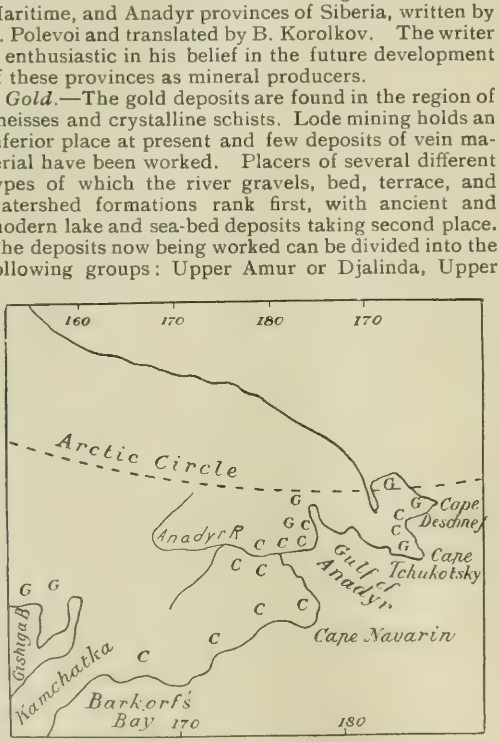
The signal success of Arrhenius as a pioneer in physical chemistry was recognized in his native country, as it had been abroad, and thus reacted favourably on his further career. In 1895 he received a call to the chair of physics in the then newly-founded University of Stockholm. In this position he displayed such extraordinary ability as a leader and organizer that the faculty elected him Rector of the University in 1897. He was repeatedly re-elected to this responsible post, but later declined re-election, as he felt that the duties of the office seriously interfered with his scientific pursuits. In 1903 he was awarded the Nobel prize in physics, and two years later he was appointed director of the Physical Institute of the Nobel Foundation. The laboratory building was erected according to his plans and under his direction.

Most of the papers on the dissociation theory were published by Arrhenius while he was working in foreign laboratories. After his return to Sweden his research work took different directions, largely along lines of cosmic physics. In 1905 he published a treatise on cosmic physics in two volumes. In this remarkable work he embodied a series of investigations of which many were made by him and Ekholm jointly, while others were carried out by himself alone. They cover a wide range of subjects and reveal anew his astounding resourcefulness and originality. While not a few of the views here expressed are still discussed and contested, there can be no doubt that the discussion of such fundamental questions as the origin and present state of sidereal bodies has profoundly influenced and greatly stimulated the scientific thought of our time. The more popular book, "Worlds in the Making," published more recently, gives a fascinating summary of the subject, from Arrhenius' point of view. Among the many new conceptions introduced by Arrhenius into the study of cosmogony is that of the rôle he ascribes to the pressure of light in cosmic changes. He points out that the potency of this agent increases with the degree of division of matter, and thus becomes a most important factor in the phenomena of cosmic dust, nebulæ, the aurora, comets' tails, etc. His views on the origin and distribution of life are also interesting.

MINING IN FAR EASTERN SIBERIA.

The *Far Eastern Review* (Shanghai) for June contains an article on mines and mining in the Amur, Maritime, and Anadyr provinces of Siberia, written by P. Polevoi and translated by B. Korolkov. The writer is enthusiastic in his belief in the future development of these provinces as mineral producers.

Gold.—The gold deposits are found in the region of gneisses and crystalline schists. Lode mining holds an inferior place at present and few deposits of vein material have been worked. Placers of several different types of which the river gravels, bed, terrace, and watershed formations rank first, with ancient and modern lake and sea-bed deposits taking second place. The deposits now being worked can be divided into the following groups: Upper Amur or Djalinda, Upper



THE ANADYR PENINSULA.
G=Gold Deposits; C=Coal Deposits.

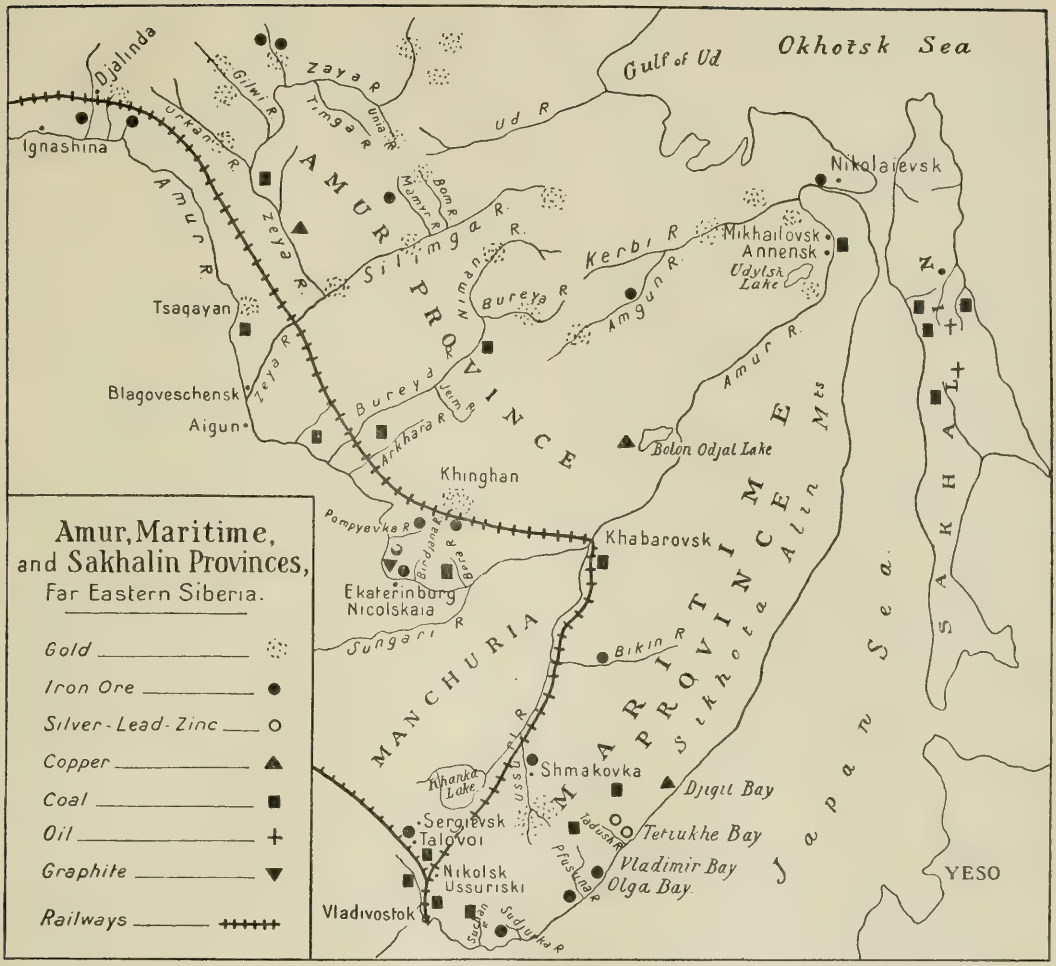
Zeya, Middle Zeya or Guiluy, Lower Zeya or Urkan, Unia-Bom, Upper Silinja, Lower Silinja, Niman Little Khingan, Kerbin, Middle and Lower Amgun, Lower Amur, Udylsk Lake, Sikhota Alin, South Ussuri, Okhotsk, Guijiga, Kamchatka and Chukotsk-Anadyr. The thickness of the deposits varies greatly, but is usually between 10 and 20 ft. The deepest placers are those of the Lake and the Niman group, where deposits from 35 to 70 ft. have been found.

In 1915 there were 282 placers being worked and 5,742 permits to prospect had been applied for. Surveys were made of 1,353 gold-bearing areas and permits issued for their working. Of these 2 were worked by hydraulicking, 7 by dredging, and 2 by other mechanical excavators. There also were 397 tribute workings by smaller groups who operated under licence from the concession holders. The larger operators produced 4,457·7 pounds, while the tributers won 8,846·95 lb. The distribution of the gold produced in the several mining districts was as follows: Amur district, 2,199·19 lb.; Bureya, 3,407·55 lb., Zeya, 2,475·37 lb., Maritime 5,064·45 lb., and Ussuri 158·12 lb., a total of 13,304·68 pounds reported to the government authorities. Practically all this output came from the placers, as the only lode mining reported was from the Ussuri district with an output of some three poods or 108 pounds. The workmen numbered 24,549 in all these mining areas, and were largely Chinese, who supplied 76·2%, with Koreans 13·4%, while the Russian miners were only 10·4%. The larger part of the workmen were employed on the tribute basis.

Those familiar with conditions in Siberian mining areas look for large extensions along the three following lines: New discoveries, intensification of production in existing fields, and the discovery and development of reef gold. In the first of these categories, new discoveries are to be expected in the north-east, in the Udsk, Okhotsk, Kamchatka, and Chukotsk regions, also on the tributaries of the Upper Bureya. Another promising area is that between the Amur and the middle course of the Amgun, while the Ussuri slope of the Sikhota-Alin range has great possibilities. Hydraulic mining could be applied with success on the Zeya, Unia Bom, Upper Silinja, and Niman regions, and dredging in the Kharga-Zeya and Kerby river in the Ussuri district. In the Udsk country and elsewhere the frozen gold-bearing ground is of large extent.

Gold in lodes has been found in the Ussuri, Amur, and Kolchan regions. The difficulty in the way of systematic development is the lack of any scientific information regarding the country.

Iron.—Iron deposits have been known for more than 75 years, but little attention was paid them owing to the quicker returns to be obtained from gold placers. Magnetite deposits are known, but have not been fully explored in the Amur province; the basin of the Mamyn, and the upper reaches of the Yvatikane are especially promising, while some discoveries have been made in the Great Sugdjara, Bryanta, Oldoi, and Amgun river regions, as well as on the lower Amur. The chief magnetite deposits are in the South Ussuri district where the Olginsk area is the richest. These deposits are found in the contact of limestone and granite, the former being the most important factor. The best deposit now known is that of the Bielaya-Gora, or White Mountain, on the right bank of the Arzamassovka rivulet, where three huge lenses and some rich pocket deposits have been located near the Serafimovka village. True magnetic ore is found in the St. Olga and St. Vladimir bays, and this is held to be second in importance of magnetite deposits. Other regions of iron ore are on the Sudzukhe river, near the Talovoi branch on the Ussuri railway and in other localities of the Ussuri district. The average percentage of iron



in these deposits is not high, running about 40%, although some parts of the deposits are much more promising. It is possible that with depth the quality of the ore will improve or that sulphurous ores will take the place of the magnetite. The ores now known must be concentrated before smelting, but the cost of this in the case of magnetite is not prohibitive. After a survey in 1917, the total ore in the Bielaya Gora deposits was estimated at 2,040,215 tons, while the Sergievsk and Sudzukhe ores aggregated 243,745 tons more, a total of 2,283,960 tons.

Hematite ranks second. It is found in the Little Khingan mountains mostly in connection with a series of metamorphosed limestone, hornstone, and slate. The deposits are situated in two layers, the southern stretching from the Amur, near the village of Ekaterino-Nikolskoye, to the river Pompeevka, and the northern from the Londoko station on the Amur railway to the upper part of the Bidjan river. The beds are generally in the form of lenses which sometimes attain a thickness of about 140 ft., the percentage of iron in the ore varying from 35 to 65%. The total ore of the southern field is estimated at about 2,708,250 tons, but the northern deposits have scarcely been explored at all. This ore must also be concentrated before smelting and separated from the intermixture of hornstone.

The Sergievsk deposits in the Ussuri district are not hematite, but consist of magnetite and bog ore. Bog-ore deposits are frequent in the area of Sudsukhe and on the lower Amur, one of the most important being situated within the town of Nicolaievsk on the Amur. It is a lacustrine deposit stretching over basalt formations containing a considerable percentage of iron and has been formed in the Quaternary period by sediments of ferruginous springs. These ore deposits generally take the shape of lenses. According to several estimates they contain about 902,750 tons of ore, with a percentage of iron from 40 to 50 per cent.

The outlook for the iron industry here is not very bright, and it would take long and strenuous research work and the opening of the country to civilization in order to put it on the same basis as Western and Central Siberia, though the far-eastern deposits are by far the richest in Russian North-Asia. The vicinity of coal mines in the Suchan area and on Russian Sakhalin and transport facilities as offered by the sea, the Amur river, and the Amur railway, all tend to encourage the development of the iron industry, at least on a small scale.

Actually iron ore is produced only in the Olginsk and Sergievsk districts. With the prevalence of a system of compulsory production (about 44,500 cubic feet per claim being obligatory) the average yearly output varies between 9,000 and 18,000 tons. The producers have many a time, but unsuccessfully, applied for a permit to sell the ore to Japan.

Silver, Lead, Zinc.—Silver, lead, and zinc deposits are known to exist in the Russian Far East from the Chukotsk peninsula down to Korea, and others from Transbaikalia to the Pacific. The largest deposits in the Russian Far East are those situated on the southern part of Sikhota Alin range, and particularly in the area of Tetiukhe. The ore is found in a deposit of the contact metamorphic type, and consists of sulphide minerals, galena and blende, on which lie calamine, smithsonite, and ochreous substances. The total quantity of ore is estimated at from 1,765,000 to 2,000,000 tons, containing, on the average, 12% lead, 17% zinc, and 280 grammes of silver per metric ton. The mill is in a position to treat annually 50,000 tons of ore, the produce being lead concentrate, containing 70 to 72% lead, and zinc concentrate containing 33·37 zinc. Modern methods of concentration could be applied to advantage. There being no smelters, the enterprise is dependent upon the Japanese market for lead concentrate. The present output of the Tetiukhe works could be easily raised to 63,000 tons of lead, 7,200 tons of zinc, and 25,300 lb. of silver. At the same time it would be possible to develop a considerable sulphuric acid industry.

The other deposits in the Ussuri district, those of Olginsk, and on the Pfusun and Wanchin rivers, are not so important. Some deposits of argentiferous pyrites have been discovered on the Kamchatka peninsula and along the coast of the Okhotsk sea.

The following is the output of the mines in the Tetiukhe district in short tons :

	Sulphide ores.	Calamine.
1911	4,913	26,907
1912	5,629	31,420
1913	33,184	29,482
1914	69,572	23,432
1915	55,124	8,673
1916	62,382	5,993
1917	104,975	783

Copper.—Indications of copper are abundant in the Russian Far East, as a glance at the map will show. Up to the present time mining work has been done only on two of the Ussuri district deposits, situated on the Djigit bay and owned by the Siberian Mining Co (Peppel and Ozmidoff). One of these deposits is on the sea shore, interbedded in metamorphic slates. The other lies in the valley and is a lode deposit. In both cases the ore mineral is chalcopyrite. The average content is not more than 1·5% of metal, which is not sufficient for industrial purposes in the Russian Far East. The Djigit mines would never be able to compete with the copper industry in Japan, nor with the rich copper deposits in Western Siberia, which are gold-bearing.

Information as to other mineral substances of the country is scanty, and no particular attention has ever been paid to them. Considerable deposits of antimony have been discovered on the Boguchan mountains; graphite, on the Amur river (near the village Soyuzny); and sulphur on the Kamchatka peninsula. In addition arsenic ores, cinnabar, mica, and other minerals have been traced. Up to the present time salt has nowhere been discovered and there are no prospects of discovering it. This is greatly to be regretted, as salt is one of the most necessary commodities to the flourishing fishing industry of the Russian Far East. It would not pay to carry salt from the Yakutsk province, and, probably, it will be imported again from Germany and South Russia, via the Suez Canal, as soon as freight rates get lower.

Coal.—The coal deposits of the Russian Far East, situated more or less closely to the coast of the Pacific Ocean, are destined to play a very important rôle in the future. All kinds of coal are found in the Russian Far East, brown coals and bituminous coals, long-flamed and anthracite. Excepting Kamchatka and the region to the north of it, most deposits of bituminous coal on the continent are of the Jurassic period, and the brown coals are Upper Tertiary. In the Amur province bituminous coal has been discovered in the area of Zeya-Depsk, Bureya-Terminsk, and along the river Bira, and brown coal in the Bureya-Zavitinsk region, on the Arkhara river, the Zagayan mountains, and several others. The South Ussuri district ranks first in the Maritime Province, and the most important bituminous deposits are situated near the cities of Vladivostok and Nikolsk-Ussurisk, on the northern slopes of the Sikhota-Alin range, on the lower course of the Amur near the village of Mikhailovsk. Brown coal has been found in the Vladivostok area, on the river Tadush, near the city of Khabarovsk, and in some other places.

In the island of Sakhalin and the Kamchatka peninsula the coal-bearing strata are much the same as in Japan, Canada, and Alaska. The island of Sakhalin contains the richest coal deposits in the Russian Far East. The principal area is situated along the western mountain range, and stretches from the river Viakhtu to the Japanese or southern part of the island. In the east, coal is found on the eastern slope of the eastern range from the Ossoy mountain to the Nabil river. Several less important deposits exist in the northern part of the island. The coal district in Kamchatka, lying between Baron Korff's bay and the Anadyr river, is but little explored.

The importance of the deposits on the mainland is purely local, whereas Sakhalin coal might acquire a world-wide reputation. Kamchatka's deposits may serve to give additional freight to ships plying northward and provide them with coal for the way home. But all this is a question of a more or less remote future, as the coal deposits of the Russian Far East are practically unexplored. The estimated reserve of coal in the Russian Far East amounts to more than 3,000 millions of tons. The Sakhalin coal is of the highest standard, and its best sorts, particularly those of Dui, excel those of Japan.

Petroleum.—It is difficult to draw any conclusions as to the oil-bearing districts until a careful investigation has taken place. On Sakhalin island oil has been discovered on the east coast from the Okha river in the north and almost down to the Languery river in the south, a distance of about 180 miles. The geological expedition in 1908–10 located 14 seepages, and at present 20 are known. Oil has also been proved by 9 deep bores, 2 on the Noglik, 2 on the Nutovo, 4 on the Boatassyn, and 1 on the Okha river. The average depth of these bore-holes is about 480 ft., the deepest being that on the Boatassyn river, which is 930 ft. Boring was not done scientifically from a geological point of view. It was mostly of a casual character and depended upon the facility of obtaining the necessary implements, and was carried out in places where there were natural seepages of oil. The quality of the oil improved with depth. The oil contains but little benzine and no paraffin, and is of the naphthaline quality. There is no doubt that oil of a better quality will be discovered in Sakhalin.

APPLICATIONS OF ELECTROLYSIS IN METALLURGY.

In *Chemical and Metallurgical Engineering* for July 21, Lawrence Addicks discusses the various applications of electrolysis in refining and other metallurgical operations other than the refining of copper.

Electrolytic refining has attained its chief application and highest development in the metallurgy of copper. The experience here gained has found wide application in the refining of other metals, such as silver, gold, lead, bismuth, tin, nickel, iron, and zinc, and in the recovery direct from the ore by leaching of copper, silver, gold, and zinc. The successful application of electrolysis in these different directions requires a re-balancing in the various factors making for success with copper. In any given case we must take into account: (1) competition from other processes, (2) acid radical to be employed, (3) temperature of electrolyte, (4) character of deposit, (5) re-solution at the cathode, and (6) depolarization at the anode.

(1) Electrolytic copper refining has no effective competitor. Fire refining makes a low conductivity product unless furnished with very pure raw material such as selected Lake "mineral," and the various selective methods of reverberatory treatment yield but a partial recovery of gold and silver.

In leaching, electrolysis has to meet several competitive methods of reduction, notably precipitation upon iron. While a free acid equivalent by electrolysing is returned to the cycle, there are usually serious handicaps imposed by large quantities of impurities which cause various troubles in the cells and which progressively accumulate unless some outlet is provided. Even where electrolysis is indicated, therefore, an iron precipitation plant is usually required as an adjunct, from 10 to 30% of the copper being recovered as cement.

Electrolytic silver has to compete with the older sulphuric-acid method of parting. The latter is easy to operate and ties up less silver, but it will not make a product so low in gold as the electrolytic. It is still indicated, however, for small plants or for those which are used spasmodically.

In the case of gold-refining, the question is almost wholly dependent upon the amount of platinum and associated metals present. If the original gold is free from metals of this group, there is no object in tying up the gold several days for electrolysis and further increasing the opportunities for theft. When only very small quantities of platinum and palladium are present, they may be satisfactorily collected by wet methods instead of by electrolysis at about equal expense. When the quantities are larger electrolysis is indicated.

Electrolytic lead has to compete with the very efficient Parkes process of refining. When all factors are considered, the justification for electrolysis appears to rest almost entirely upon the quantity of bismuth present in the bullion to be treated. This objectionable impurity is not satisfactorily removed by the Parkes process, and special treatments such as Pattisonizing are expensive, while the electrolytic method readily separates the bismuth from the lead and converts it into a marketable by-product.

Nickel, iron, and zinc may be readily refined by electrolysis, but in ordinary times the value of the refined product, except in a very limited quantity, is not sufficiently above that of the crude to pay for the refining. Impure ores, and tin, which are difficult to handle by fire processes, may be treated satisfactorily by electrolysis.

In leaching, both nickel and zinc have strong competition from chemical and pyrometallurgical processes.

In general, we can say that these applications of electrolysis are not so obviously advantageous as is the case in copper refining, and that each proposed application must, therefore, receive full consideration upon its merits.

(2) While several salts of copper are suitable for electrolytic treatment, the sulphate possesses so many practical advantages that it is universally employed. The first requirement for an electrolyte is that the salt of the metal employed shall be readily soluble. The second is that the material which it is desired to collect in the slime shall be insoluble in it. The third is that the cathode should not be redissolved by the electrolyte. Copper sulphate is a readily soluble salt, and copper, gold, and silver are all practically unattacked by dilute sulphuric acid.

When electrolysing silver, a nitrate electrolyte is employed, as silver sulphate is not a readily soluble salt. The amount of free acid carried is necessarily low, as nitric acid is expensive and decomposes under the conditions of electrolysis. Copper concentrates in the electrolyte and is removed by withdrawals, while gold remains unattacked in the slimes.

In gold-refining, a chloride electrolyte is employed. Gold chloride is a soluble salt, platinum concentrates in the electrolyte, and although silver, being less noble than gold, dissolves at the anode, after saturation it precipitates as a secondary slime of insoluble chloride.

For lead, chloride and acetate were first tried, but not until Betts developed the fluosilicate electrolyte was the electrolytic refining of lead made a commercial success.

It will, therefore, be appreciated that an entirely new set of chemical conditions as regards behaviour of impurities, etc., is encountered with every metal refined.

(3) While it is customary to heat copper electrolytes externally, quite opposite conditions obtain in the case of silver, lead, and zinc. Nitric and hydrofluosilicic acids show increasing decomposition losses with rise in temperature, asphalted tanks do not stand hot liquors, and zinc re-solution losses must be limited. In the case of silver, the current may have to be limited to control the temperature; for lead, extraneous heating is abandoned, and with zinc, where the specific resistance of the electrolyte is high, cooling systems carrying circulating water must be employed.

(4) At moderate densities copper readily gives a good adherent deposit. The same may be said of gold. Silver gives normally a loose crystalline deposit. Nickel is nodular, while lead and zinc tree very badly. By the proper use of addition agents, all of these deposits may be made smooth and coherent. In fact it was not until the value of addition agents was more or less understood that lead could be handled at all.

In the early copper plants a great deal of trouble was experienced in getting good starting sheets, and it was thought that the addition of ammonium sulphate was a help, the use of double salts being common practice in various electroplating prescriptions. Then the beneficial effect of the presence of wood strips on the edges of the starting blanks led to the introduction of wood tea made from shavings, yielding a complex organic addition agent. Finally, the remarkable results following the addition of gelatine were worked out. The irregularities of early practice were due to overdosing and a failure to appreciate the fleeting effect of a single dose. To-day a few pounds of common glue dissolved in water and added regularly throughout the twenty-four hours, together with a can of ordinary engine oil, will control the deposit in the tank house of a great copper refinery, permitting the use of higher densities, closer spacing, and greater cathode age.

For silver, while adherent deposits can be made in similar fashion, it is customary to collect the silver crystals as such, either brushed to the floor of the tank from vertical cathodes by mechanical scrapers as in the Moebius system, or shovelled by hand from the horizontal carbon cathode of the Thum cell. These crystals are readily washed free of electrolyte and fed to retorts for melting.

Lead may be beautifully controlled by addition agents. The exact amount to be added varies from time to time, and is determined by experiment and careful watching of the fresh deposit on special strips hung for the purpose.

Zinc is generally plated in coherent form on an aluminium cathode, from which it is peeled every forty-eight hours. There is no reason why zinc starting-sheets could not be used as in the case of copper, and in some ways the avoidance of a zinc-aluminium couple would be of advantage. In the development of electrolytic zinc practice, however, there has been great difficulty in controlling re-solution at the cathode, and the great advantage of using aluminium sheets lies in the fact that strong corrosion can do no more than leave the starting-sheets bare, whereas were they of zinc they might be completely eaten through, causing collapse, open circuits, general demoralization, and shut-down of the plant.

(5) The cathode is never absolutely insoluble in the electrolyte used and a small amount of reoxidation is always in process. In the case of copper with normal electrolytes it is a minor matter—perhaps 2%. Should we allow an accumulation to take place of salts of manganese, iron, or any other metal capable of alternate oxidation and reduction at anode and cathode with change of valence, a very serious condition may arise.

In these days copper anodes are so highly refined that the amount of iron contained in the electrolyte is quite negligible, but when electrolysing liquors arising from the leaching of ore a very different situation exists. Such liquors commonly contain large quantities of ferrous sulphate and a certain proportion of ferric sulphate. Oxidation at the anode tends to increase the latter at the expense of the former. Experiments show that 0·25% of iron as ferric sulphate in an electrolyte sufficiently agitated will corrode cathode copper at a rate which will require a current corresponding to about 8 amperes per sq. ft. merely to replace the loss. The proper control of ferric sulphate is, therefore, the key to success in electrolysing copper-leaching liquors.

Another interesting example of re-solution is in the case of zinc, in fact this is the controlling factor in zinc electrolysis. In the electrolysis of zinc sulphate using an insoluble anode the content of free sulphuric acid gradually increases, and unless the cathode is absolutely pure, zinc re-solution is very active. Perfectly pure zinc is so nearly insoluble in sulphuric acid that it is quite difficult to get it in solution for analysis. But if a nodule of cathode zinc is immersed in dilute sulphuric acid in a test and the merest trace of almost any impurity is added, a vigorous evolution of hydrogen will start at once. This is probably due to galvanic action, and the whole secret of successful zinc electrolysis lies in the passivity of pure zinc in sulphuric acid. This calls for a degree of purity in the electrolyte which would be quite uncommercial were it not for the fact that zinc dust readily throws down most of the impurities to be dealt with after the liquor from the leaching tanks has been neutralized. The last traces of some difficult elements, such as arsenic, are removed by adsorption upon freshly made ferric hydrate.

(6) Anode efficiency plays a relatively small part in normal copper refining; the proportion of impurities present in the anode is small and the useful anode efficiency very high. As soon as a complex or insoluble anode is substituted, however, the oxidizing effect of the current is in part or in whole employed in the solution of anode impurities, the oxidation of suitable salts in the electrolyte, or in the decomposition of water with escape of oxygen as such. This introduces several new problems.

A moderate amount of an oxidizable impurity, such as nickel, in a copper anode gives the first and simplest case. The nickel and copper dissolve proportionately at the anode, sharing the current. At the cathode, however, only copper is deposited, so that the copper in the electrolyte is correspondingly depleted. About 2% of the copper deposited is restored by purely chemical solution at the electrodes, but beyond that figure soluble copper must be added by leaching shot or scale, and the accumulating nickel must be controlled by withdrawals to a by-product plant.

The second difficulty arises when the quantity and nature of the impurity in anode causes segregation into two components one of which is more readily dissolved than the other. Then the anode disintegrates unevenly and a large amount of scrap has to be re-worked.

A third and more serious condition is met with when the impurity is insoluble, such as lead or antimony, when the anode will become coated with a non-conducting slime. The voltage will then rise until some free oxygen is generated from the moisture underneath. This in turn will burst through the coating and the anode will act normally for a few seconds, when the coating will again form. A voltmeter connected across such a tank will show a wildly fluctuating needle, and this condition, known colloquially as "crazy tanks," is fatal to good refining, entailing as it does excessive gold and silver losses in the cathode, high power cost, and a heavy expense for purifying electrolyte. The remedy lies in properly refining the crude material before casting the anodes.

Finally, we have the extreme case where the anode is by intent insoluble, as where copper is being recovered from leaching liquor. Where no depolarizer is employed, the voltage must, of course, be sufficiently high to decompose water, and free oxygen is given off at the anode. When the liquor is virtually free from chlorides and nitrates, antimonial lead is generally used as the anode material; when electrolysing zinc, however, pure lead is required in order not to poison the cathode with specks of antimony. When the liquor is corrosive, either magnetite or one of the ferro-alloys, generally ferro-silicon, is employed. None of these anode materials is wholly free from oxygen attack. Lead peroxidizes and sulphatizes and the iron alloys slowly dissolve, so that a certain replacement charge must be reckoned with.

Where an efficient depolarizer is employed, any of the materials mentioned above or carbon may be employed. Graphite offers peculiar advantages in that 100% of efficiency of oxidation of ferrous sulphate or similar depolarizer is readily obtained by its use. Lead does not give equal results. On the other hand carbon itself will oxidize and disintegrate if not fully protected by the depolarizer. This whole question of a cyclic oxidization at the anode with subsequent reduction at the ore contact is yet in but partially developed form, most of the theoretical advantages being generally offset in practice by the difficulties met with in handling impurities dissolved from the ore.

Tungsten in New South Wales.—In *Chemical Engineering and Mining Review* for June, C. Lonsdale Smith describes the scheelite-wolfram mines, worked by a Sydney company called Tungsten Mines, Ltd., situated two miles from Frogmore and seventeen miles north of Boorowa, the nearest railway station.

The lodes occur in Silurian slates. Granite outcrops half a mile to the east, while basalt appears a few chains distant from the south-west corner of the leases. The ore is found in a series of short lenses up to 12 ft. in length and 45 in. wide, the portion between showing only a few inches of ore in the upper levels, though below water-level this disparity in the width is not so marked. Half-a-dozen lode formations have thus far been exposed in cross-cuts, all of which have carried appreciable WO_3 contents. Development has been confined principally to the main lode, which has been exposed on the surface for a length of 1,200 ft. and has been stoped for over 600 ft. in length above Nos. 1 and 2 levels.

In past years the mine was worked by shafts which followed the dip of the lode, and by a tunnel connecting with No. 1 level. The hauling down to No. 2 level was done by whip-horse and bucket. The records show that 6,584 tons of ore was raised and treated for a yield of 101 tons of concentrates, assaying approximately 68% WO_3. Crushing was done in those days by two Nissen stamps, hand fed, the pulp going direct to two Wilfley tables.

Recently a main hauling shaft has been sunk east of the lode to a depth of 180 ft. The No. 1 cross-cut from the shaft connects with the old workings at No. 2 level, while the bottom cross-cut intersected the lode below water-level at a vertical depth of 220 ft. below the lode outcrop. Levels have been opened up for 280 ft. in length from the bottom cross-cut on a lode averaging 20 in. in width, averaging 2% WO_3, and ventilation has been established with the upper workings by winze connection from No. 2 level. The extension of the north level will open up ore of the higher grade exposed in the level above and in two winzes, besides giving some 10,000 tons of ore to work out above this level on the main lode alone.

In the upper workings wolfram predominated largely over scheelite, while below water-level the reverse obtains, the proportion being 5% scheelite to 1% wolfram. Bismuth occurs in relatively small quantities. Tungstate of copper has been found in the upper levels on the western lode, while galena in small quantities, and iron pyrites in occasional heavy patches occur below water-level.

The present practice in dressing is as follows: The ore is tipped into an ore bin and trammed to the battery, passing over the grizzly to an Acme 12 by 6 in. rock-breaker, then into the battery hopper fitted with three rack doors delivering to three Challenge ore feeders. Each Nissen stamp is provided with a self-feeder, as is also the 5 ft. Huntington mill recently installed. Wire-woven screens with 196 holes per sq. in. are used. The pulp from the stamps and Huntington mill go to a hydraulic classifier and overflow from classifier to settler. The classified ore is then passed on to two Wilfleys and one Card table, the seconds from these being de-watered and treated on a Frue vanner. A third Wilfley is used sometimes as a stand-by while any necessary repairs are being made to the vanner. All the tailings are sent by launder to a V-box with discharge pipe at the bottom for coarse sands, while the overflow discharges the slimes into a wooden box fitted with pipes to convey the slimes to the distributing box at the head of the strakes. The strakes are 30 ft. long by 11 ft. wide overall, and divided into partitions the width of a cornsack. Good second-hand cornsacks are used; the side-stitching is ripped down and the bag is laid full length. When the bags are sufficiently charged, each 30 feet length is hosed down in turn and the slimes are allowed to settle in a box before the surplus water is drained off. By careful attention to these bag strakes, the usual loss of slime scheelite is greatly diminished; but the personal equation has to be reckoned with, especially on night shift, as recorded by the tailings sampler below the strakes. Other ore-dressing appliances in use are a hydraulic cleaner, square and round buddles, and a kieve, or tossing tub. The round buddle in particular is invaluable for dressing the slime product from the strakes. Owing to the amount of iron pyrites present, a high-grade concentrate is not possible, so the grade is maintained at 65% WO_3. Experiments made in calcining low-grade concentrates consisting of heavy iron pyrites and fine scheelite-wolfram with subsequent re-treatment, show that a high-grade concentrate can be produced by this process. Additional settling vats for slimes with treatment on slime tables of the Ferrari type are proposed. The company has over 5,000 tons of tailings stacked of a sampled value of 1% WO_3, which will require re-grinding before concentration. Recent crushings of 577 tons yielded 10½ tons concentrates, but the drought conditions which are affecting most of the N.S.W. mining districts forced production to cease in February. The company has three dams, but the holding capacity is comparatively small, and other arrangements are being made.

Chemical Sheet Lead.—The *Journal* of the Society of Chemical Industry for July 31 contains a paper by D. W. Jones, of Locke, Blackett & Co., on tests for impurities in lead that render it unsuitable for use in making sulphuric acid chambers. The method of test most generally favoured is to heat in concentrated sulphuric acid and observe the temperatures at which bubbles of gas are first evolved and at which the lead decomposes. When under observation by this method in some cases the decomposition of lead is sudden, total, and violent, and is attended by a rise of temperature after removing the source of heat up to 27°C. With a good quality lead decomposition proceeds slowly, and is arrested when the source of heat is removed.

From the author's tests it is made evident that the presence of antimony in lead to the extent of 0·01% renders it unfit for use in the manufacture of chemical plant. With 0·06% of added antimony the temperature of initial attack is restored, but as this amount is never found in commercial lead (which is usually of a purity of 99·98%) and it is not conceivable that an addition of 0·06% antimony would materially lead to additional strength, there can be little or no advantage derived from the fact. Hard lead sheet and pipe containing 0·75–5·25% Sb in no case gave a higher decomposition temperature than 244°C., but at temperatures above 220°C. signs of gas bubbles are first observed when this type of lead is heated in concentrated sulphuric acid. Antimony, therefore, if present in lead in practically any proportion above the most minute, will, in the absence of a known corrective agent, be the cause of immediate breakdown if temperatures much over 200°C. are employed.

Copper also has a marked effect in reducing the temperature of initial attack by sulphuric acid. The figures given by the author point to the fact that there is a danger zone lying beyond 0·03% in lead of the Parkes type, and in the chemical lead clearly defined between 0·03 and 0·045%. If copper be introduced, due consideration must be given to the above-mentioned factors. The effect upon the decomposition temperature of the addition of copper upon a Parkes lead is most beneficial; 0·005% introduced shows a rise of as much as 23°C., and at the same time is sufficient to prevent the vigorous action which causes the whole of the lead to be converted into sulphate and consequent total destruction. The gain achieved by introducing 0·03% is 37°C., and brings an ordinary lead within measurable distance of chemical lead. No remarkable effect ensues from the addition of copper to a pure chemical lead; a gain of 4°C. at 0·04% addition is all that calls for comment.

The effect of copper in counteracting the harmful influence of antimony in lead is shown by the author's results. In no case is total decomposition brought about, which, with antimony only present to the same extent, would result in every instance. With between 0·02 and 0·03% of antimony and copper there seems to be a rise in the temperature of initial attack; this fact may be of some value if lead containing these amounts of antimony and copper is used for purposes dealing with concentrated acid at comparatively low temperatures.

Zinc, when present in lead even in very small amounts, is generally supposed to destroy the power to withstand the corrosive action of acid in a marked degree; this is not borne out by any work undertaken by the author, which embraces the examination of chemical lead prepared by different methods to which additions of zinc have been made. The temperature at which the first action is discernible is lowered in all cases. At 0·02 and 0·05% a degradation of resistivity is evidenced by the formation of lead sulphate much below the temperature of complete solution. At 0·03–0·04% Zn a critical stage exists where this injurious effect is not operative.

Mercury when alloyed with lead has a deleterious effect upon its chemical properties. By amalgamation this effect is more serious. If 1% of mercury is rubbed over the surface of a piece of chemical lead until amalgamation appears to be completed, allowing one hour as contact time, the product is very sensitive to the action of hot concentrated sulphuric acid. At 170°C. lead sulphate is formed copiously. If the heating be discontinued at this stage the action of the acid will cease on cooling to 70°C. After washing the lead sulphate from the trial piece it will be observed that pitting has proceeded over the entire surface, and minute globules of mercury can be seen under the microscope. If this piece of lead be again heated with sulphuric acid action will commence at 180°C., and sudden, total, and violent decomposition will take place at 220°C. Repeating the above, but allowing contact overnight between the lead and mercury for more complete amalgamation, a distinct action is noticeable on heating to 50°C. At 100°C. total decomposition accompanied by the usual phenomena takes place. These observations indicate that great care must be exercised when using hydrometers, etc., for if these instruments are broken and the mercury permitted to amalgamate with the lead, local action in the affected part, followed by a breakdown, can be expected.

Tin has a degrading influence upon lead intended for chemical purposes, though not to the extent generally believed. Since it is easily removed by refining methods of to-day, it is not usually found in lead in more than minute traces.

Bismuth, so frequently associated with lead of American origin, is decidedly injurious if present above 0·04%, and even at 0·02% it causes total decomposition in an otherwise resistant lead. The addition of 0·02% of copper to lead containing 0·05% bismuth will be sufficient to raise the temperature of decomposition from 273°C. to 300°C.

The combined effect of antimony and bismuth is noteworthy. The addition of 0·005% of each metal leaves chemical lead practically unaltered, but when 0·02% antimony and 0·02% bismuth are present there is a difference of only 12°C. between the temperatures of first action and of violent decomposition. Doubtless the poor chemical quality of Parkes lead in some instances is due to its containing antimony and bismuth in some peculiar proportion, as singly their effect when added to a pure lead is not so pronounced.

Earth Tremors on the Rand.—The July *Journal* of the South African Institution of Engineers contains a paper by Percy Cazalet giving a review of his investigations into the occurrence and causes of earth tremors on the Rand. During the past ten years full records have been kept by seismograph at the Union Observatory at Johannesburg, and many different classifications of the records have been made by Mr. Cazalet with the object of establishing some law governing the periodicity of recurrence and of ascertaining the ultimate cause of the tremors. His most interesting point is that relating to the connection between shocks and rainfall. On plotting the rainfall figures on the same chart as the tremor figures, a remarkable similarity in the curves was immediately observed, and when the rainfall figures were retarded 5½ months, the curves became almost coincident. No one can, of course, be prepared at present to say definitely that the shocks are affected by the absence or presence of water in the strata, but Mr. Cazalet has always believed that such direct connection does exist, and he even called the attention of the 1915 Earth Tremors Commission to this possibility. He is now inclined to believe still more, as the result of the study which this investigation has necessitated, that the connection is direct and very close. At the same time he fully recognizes that curves of any similar records that are seasonal, as for instance average temperature or barometrical readings, might also be manipulated, as he has done with these curves, to indicate somewhat similar relationships. While this is so, there is also the fact that the probabilities are in favour of a waterlogged or relatively dry state of the strata having some effect on the retardation or encouragement of its rupture when submitted to undue strain by undermining. If the finding of the Commission is correct, that the bursting of a pillar or pillars is the prime *cause* and not the *effect* of the earth tremors, then it is natural to assume that the water content of the overlying strata is a relatively unimportant factor; but if, on the other hand, Mr. Cazalet's view is correct, and he is supported in this view by many other observers on the mines, that the earth tremors are due to the rupturing of the overlying strata due to over-strain, and that bursting pillars are only the phenomena of over-stress, following immediately on the readjustment of weight after these ruptures, then hydrostatic tension at times of ample rainfall must aid in preventing rupture, and, conversely, the absence of water and pressure of air in the interstices of the overlying strata must aggravate any induced instability, and hence encourage rupture, and therefore tremors. This portion of the investigation would be well worth the while of further and much more detailed inquiry.

Ironstone in the Midlands.—The *Iron & Coal Trades Review* for August 13 gives particulars of the new ironstone mine opened by the Ebbw Vale Steel, Iron & Coal Co., Ltd., at Irthlingborough. The ore properties are approximately 3,000 acres in extent, of which the larger part has been proved by trial pits and boreholes to contain a bed of ironstone reaching, in some parts, 15 ft. in thickness, of which it is proposed at present to work 8 to 10 ft. The reserves are estimated at 45 million tons. The ore consists of the well-known Northamptonshire stone of oolitic carbonate, lying underground, and mostly blue, grey, or green in colour, that is, very little is oxidized. Part of the area, however, contains surface ironstone. The mine has been laid out to deal with a minimum daily output of 2,000 tons, which it is expected eventually to bring up to 3,000 tons. At present the output is under 1,000 tons per day. This is the first instance in which Northampton stone has been worked on a large scale underground, although there are one or two underground mines of smaller extent in the county. The deposit has been developed by a brick tunnel approximately 1,000 yards in length, entering at the extreme southern end of the property. The tunnel is 14 ft. in diameter, and has a continuation of about 400 yards into the centre of the ironstone area that is at present being worked. This continuation is roofed by steel arch girders, the roof being extremely good. As regards water, the tunnel is arranged with a falling gradient, which serves as a drainage, and further water is drawn to a sump, where it is removed by an electric pump. The mine is, however, remarkably dry. One feature of the plant is the use of electricity throughout. The method of working is pillar-and-stall. The steel mine trams, each carrying three tons of ore, are brought from the working places by accumulator tractors to collecting sidings, and are taken from the tunnel to the calcining plant by electric locomotives of the General Electric type. These accumulator tractors have been found to work well. An entirely novel feature of the plant is the use of accumulator cars for working the electric drills. These drills are of the Blackett of Guisborough type, such as are used in the Cleveland ironstone mines, but instead of carrying the cables up to the drill a small car, carrying accumulators, is brought up, and furnishes current for operating the drill. This obviates all the difficulties that exist with running cables in a mine, and, in addition, permits the operation of the plant at low voltages. It is believed that this is the first time that such a system has been used, and it certainly works well. The system is capable of extension for use in coal-mining work, and in such an event the attitude of the Home Office towards electricity in mines might be materially modified. An accumulator charging station has been provided underground for both the drill accumulator cars and the tractor accumulator cars. The drill accumulator cars contain sufficient current to operate the drill for two days. Naturally, a drill underground is actually using current for only a small part of the time. With regard to the calcining kilns, it is noteworthy that, owing to the Northampton stone being a particularly difficult one to calcine owing to its density, half the kilns have been fitted with forced draft, which has been found to work considerably better than the natural-draft kilns, and has reduced the fuel consumption to 5% on the raw stone weight.

Talc in South Africa.—In the issue of the Magazine for October, 1918, we quoted Dr. Percy A. Wagner's report on the talc resources of South Africa, printed in the *South African Journal of Industries* for September, 1918. Since then another talc mine has been opened up in the Barberton district, and it appears as if the talc resources of that district are capable of indefinite expansion. Particulars of this mine, known as the Scotia mine, are given in the same journal for June, 1920, by T. G. Trevor, Inspector of Mines.

The Scotia mine lies on the hill immediately to the north of the Sheba railway bridge, the main adit being about 500 yards downstream, directly above the bend of the Kaap River below that bridge. The main ridge of hills here is made by the "Lily Bar," which runs east and west, making the watershed of the range and rising to some 600 to 800 ft. above the river. The backbone of the range is a hard quartzite bar dipping about 60° to the south. The talc deposits appear to be a series of beds up to 400 ft. in thickness, lying immediately above and to the south of this bar. These beds were first opened in certain workings and adits now known as Nos. 1 and 2, about halfway up the hill, but, as the talc proved of excellent quality, it was later determined to take full advantage of the backs provided by the natural slope of the ground, and two adits, known as "A" and "B," were put in at the lowest available point, about 100 ft. above the bed of the river and about 400 ft. below the outcrop. Adit "A" is immediately above the elbow of the river and is driven in some 400 ft. across the formation in a direction approximately magnetic north. Throughout its entire length the tunnel traverses talcose rocks of various degrees of purity, with occasional hard bars and some beds of very spongy limonite, which has evidently been derived from the leaching out of the magnesia from the talc, which process can still be seen going on. From 240 ft. to 270 ft. from the entrance this adit traverses 25 ft. of very pure clean talc, much of it of the foliated variety and the rest varying from grey to translucent pea-green. At this point a drive has been put in 100 ft. to the west along the bed, and this appears all to be in good talc. To the east the drive has also been continued, and for some 100 ft. or so is in good talc, but from there onward it has been driven diagonally across the formation for 300 ft. till it comes to daylight in a small kloof some 70 yards to the east of the main entrance. About 2,000 ft. to the west of "A" and on the same level another adit has been driven into the talc beds. This passes through 227 ft. of talcose rocks, similar to those traversed in "A," and then strikes a bed 15 ft. wide of good talc, if anything superior in quality to that in "A." On this bed a drive has been put in 74 ft. to the west and 76 ft. to the east, the talc in which appears to continue and to be of excellent quality. It would appear from these workings that a superior bed of talc, not less than 15 ft. thick and up to at least 25 ft. as a maximum, has been struck 400 ft. below the outcrop. Judging from the quality exposed in the surface working at No. 1 and in the drives at "A" and "B," there should be a sufficient tonnage in sight to establish a permanent industry, and the working facilities are such that the mineral can be delivered on the surface at a cost of a few shillings per ton. From the adits to the Barberton railway line is only a matter of 500 yards, and there is every natural facility for making a siding cheaply on which the mineral could be loaded direct from the mine into the railway trucks by gravitation. As the farm also belongs to the company, there is no question of way-leaves and expensive surface rights, while the immediate proximity of the Kaap River guarantees a permanent and adequate water supply.

The company's present works are situated on the old Joe's Luck machine site two miles distant, to which a level road gives access and where there is developed water power working a De Laval turbine of 100 horsepower. A new plant, capable of handling 500 tons per month, has just been erected here. The rock first passes through a Blake stone-breaker, closed up to produce a product about the size of loaf-sugar. This product is raised by a bucket elevator to a mechanically operated feed hopper, which feeds a pulverizer of the Bettington type. This machine is run at 1,600 revolutions per minute, and by the action of its beaters the rock is forced against the corrugated casing, reducing it to powder. It is claimed that this form of pulverizer retains the lustre and brilliancy of the talc which ordinary grinding between metal surfaces destroys. The beaters of the pulverizer are T-shaped and serve the dual purpose of pulverizing and blowing. This blowing action forces the powdered talc into a large balloon-shaped classifier in which there is a conical baffle. As the powder strikes this baffle the heavier particles run to the machine to be re-ground, while the finer particles are blown into a Zeppelin bag 6 ft. in diameter and 100 ft. long. This balloon is carried in the rafters of the main building, and at nine equidistant points on the bottom there are conical bagging chutes reaching to the sacking floors, where the powder which collects in them is sacked and weighed and delivered to the storage building. The grades of fineness of the first four chutes are 30,000 to 50,000 screen; the second four chutes 50,000 to 80,000 screen; while the last and ninth chute is 90,000 screen. Grades of from 30,000 to 80,000 screen are sold for foundry and industrial purposes; the 90,000 screen is used for medicinal purposes and toilet and baby powders, for which there is a very large and lucrative demand.

Gee's Centrifugal Filter.—At the annual meeting of the Society of Chemical Industry, held at Newcastle-on-Tyne in July, W. J. Gee read a paper describing his system of centrifugal filtration. Some years ago we referred to this system as applied to the purification of china clay. The system has more recently found wide application in chemistry, and its exploitation is now in the hands of Vickers, Limited. A brief summary of the paper is given herewith.

It is possible to completely remove suspended solids from a liquid, however fine the particles, in a solid drum machine by centrifugal force exerted over a sufficient time. But in many cases the last few grains per gallon of exceptionally fine particles require so much time that the output of the apparatus is severely limited. The inventor has found that some 98 to 99% of the total solids could be recovered at a very high rate of feed to the machine, but to recover the other 1 or 2% the feed had to be reduced beyond what would be a commercially practicable limit. In one case, to obtain a perfectly clear effluent, he had to cut down the feed to one-thirtieth of the rate at which 98·5% was recovered. Consequently, in cases where the liquid is required to be completely clarified, it was necessary to evolve some method of dealing with the finer particles with an efficiency more nearly approaching that at which the larger solids are dealt with by centrifugal force. The possibility of using a filter for this purpose, using the pressure derived from centrifugal force, was obvious, but a peripheral filter would readily choke, and bring one back speedily to imperforate drum conditions. Fortunately he had some prior experience which led him to consider the possibility of an exit flow under a centrifugal head, and he found in this a complete solution of the choking difficulty. In the final form of the apparatus, which combines centrifugal separation with filtration through a non-choking filter, a drum is secured to the base by a bayonet-jointed locking-ring, the base being attached to a spindle suspended from a patent ball-bearing. Rotation is imparted by a pulley. The bearing is supported by a conical pedestal, to which is riveted a top casting of steel. The pulley on the main driving shaft is fitted with a clutch of centrifugal friction type, which provides means for controlling the machine. The upper end of the drum is closed by a top plate, which makes, during rotation, a watertight joint. This plate is provided with a central opening through which the machine is charged; it is also held centrally on the spindle by a distributing plate. Depending from the top plate is the container, consisting of six vertical rods, with attached vanes or blades. These extend the whole length of the drum, being connected to the top plate, middle plate, and bottom plate. They serve the double purpose of dividing the drum into six longitudinal compartments, and compelling the liquid under treatment to rotate with the drum, so avoiding slip. Each compartment is provided with a thin residuum plate, forming a removable lining, curved to the radius of the drum. Upon these plates the recovered solids are deposited. When charged the container is lifted into the position desired. The recovered solids may then be removed without disturbance. A duplicate set of plates is supplied with each machine, and when the charged plates are removed the other set is inserted, and the machine put again into operation without delay. The charged plates are dealt with while the new charge is accumulating. Fitted to the base is a perforated filter cone, projecting into the separator drum. A filter medium, cloth, paper, or other suitable substance, is wound round and secured to the outside of the filter cone by screwed wire clamps. The lifting of the container in order to remove the recovered solids is effected by a screw and bevel gear operated by cone clutches, connected to a continuously running counter-shaft, belt-driven from the main power shaft. A nut carrying levers is connected by wire ropes to a ball-bearing turntable, provided with means of attachment to the top plate of the container. This turntable allows the container, when lifted, to be easily rotated for access to the charge.

It is claimed that the new centrifugal filter has the following advantages over other filtering apparatus: (1) The rate of filtration is constant throughout the charging period. (2) The filter, once made, is used over and over again; the removal of the recovered solids does not disturb it. (3) A very wide choice of filter material is available; such materials as filter paper, asbestos, glass cloth, and so on can be used, as bursting of filter material is eliminated. (4) The removal of the recovered solids requires much less time than the cleaning of a filter press and the fitting of clean filter cloths. (5) The wear and tear of filter material is almost completely eliminated. (6) Materials which cannot at present be filtered at all commercially in filter presses, owing to choking, can be dealt with in the centrifugal apparatus without difficulty. (7) The apparatus lends itself to heating or cooling, so that materials may be treated at any required temperature. (8) The rotor can be readily enclosed completely for the filtration of volatile or dangerous liquids, which may be treated at any pressure or temperature. In recovering suspended solids from volatile solvents, loss of solvent and danger of fire or explosion are eliminated by using a totally enclosed machine. (9) The recovered solids are graded as to fineness of particle in a very exact manner, which is unvarying on repetition, so that standard qualities of materials are assured.

SHORT NOTICES

Liquid Air Explosives.—The *Colliery Guardian* for September 3 gives particulars of investigations into liquid air explosives undertaken in England.

Mine Ventilation.—At the Cardiff meeting of the British Association, J. T. McGregor Morris read a paper describing a portable direct-reading anemometer for the measurement of ventilation of coal mines.

Centrifugal Pumps.—The *Iron and Coal Trades Review* for August 27 describes the Zeta centrifugal pump, made by the DeLaval Steam Turbine Company.

Electric Pumps.—*Engineering* for August 27 describes a submersible combined electric motor and centrifugal pump, invented by T. L. Reed Cooper.

The Eloy Hammer-Drill.—The *Colliery Guardian* for August 13 describes the Eloy drill which is extensively used in Belgian coal mines.

Copper Refining.—In *Chemical and Metallurgical Engineering* for August 4, Lawrence Addicks discusses the details involved in settling the design of an electrolytic copper refinery.

Electrolytic Zinc.—In *Chemical and Metallurgical Engineering* for August 11, L. W. Chapman describes the electrolytic zinc plant of the Consolidated Mining & Smelting Co. of Canada, at Trail, B.C.

Electrolytic Zinc.—At the meeting of the British Association, Samuel Field read a paper on the production of zinc by electrolytic methods, and recounted his work done in connection with the removal of nickel and cobalt. We hope to quote from this paper next month.

Sherardizing.—*Engineering* for August 27 describes a workshop type of sherardizing apparatus, that is to say, the method devised by Cowper-Coles for coating iron with zinc in powdered form.

International Nickel.—The *Bulletin* of the Canadian Institute of Mining and Metallurgy for July and August contains a paper on the mining and smelting operations of the International Nickel Company at Sudbury.

Metallurgy of Tin-Silver Ores.—A paper by M. G. F. Söhnlein was presented at the August meeting of the American Institute of Mining and Metallurgical Engineers describing the chloridizing-roasting of Bolivian tin-silver ores.

Burma Mines.—In the *Engineering and Mining Journal* for August 14, A. W. Jenks gives an account of the smelting of the silver-lead-zinc ores of the Bawdwin mine, Burma.

Cyanamide Manufacture.—In *Chemical and Metallurgical Engineering* for August 4, Chester H. Jones describes the process and plant for making cyanamide and ammonia compounds at the United States Government works, Muscle Shoals, Alabama.

Molybdite.—*Chemical and Metallurgical Engineering* for August 4 publishes a paper by J. P. Bonardi on molybdite, the molybdate of iron.

Komati Goldfields.—In the *South African Mining and Engineering Journal* for May 22, June 19, and July 10, James Cumming gives reminiscences of the Komati goldfields.

Silver-Lead in the Transvaal.—The *South African Mining & Engineering Journal* for July 31 gives an account of extensions of the activities of the Transvaal Silver & Base Metals Co.

Castle-an-Dinas.—The *Geological Magazine* for August contains a paper by E. H. Davison on the geology of the Castle-an-Dinas wolfram mine, Cornwall, owned by the South Crofty company.

Queensland Iron Ores.—In the *Queensland Government Mining Journal* for June, B. Dunstan, Chief Government Geologist, describes hematite deposits in Cloncurry district, North Queensland.

South African Iron & Steel.—The *South African Mining & Engineering Journal* for July 31 contains a supplement dealing with the iron and steel industries of South Africa.

Birmingham, Alabama.—In the *Engineering and Mining Journal* for August 7, G. J. Young gives an account of the iron industry of Birmingham, Alabama.

Manganese Ores in United States.—In the *Engineering and Mining Journal* for August 7, G. W. Stose writes on the production of manganese ores in Virginia and other Southern States.

Talc and Soapstone.—In *Chemical and Metallurgical Engineering* for August 11, R. B. Ladoo gives particulars of the commercial uses of talc and soapstone.

Oil in Eastern Asia.—In the *Engineering and Mining Journal* for August 14, E. M. Spieker gives an outline of Schweer's paper on Persian, Mesopotamian, and Syrian oil deposits, published in Germany.

Oil-Fuel for Locomotives.—*Engineering* for September 3 describes and illustrates the Scarab oil-fuel apparatus as applied for steam-raising on locomotives. This method has been adopted on the London and North Western Railway.

China Clay.—In the *China Clay Trade Review*, A. B. Searle commences an article discussing the true nature of china clay.

Hydro-Electric Power in New Zealand.—The *Industrial Australian and Mining Standard* for June 3 and 10 contains an article describing many schemes for developing hydro-electric power in New Zealand.

Petrographic Microscopes.—In the July issue of *Mining and Metallurgy*, W. Myron Davy describes a field microscope suitable for mining geologists.

RECENT PATENTS PUBLISHED.

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 1s. to the Patent Office, Southampton Buildings, Chancery Lane, London, W C.2., with a note of the number and year of the patent.*

1,878 of 1918 (147,958). HUTTENWERK NIEDERSCHONEWEIDE, Berlin. Manufacture of cuprous oxide by continuing the bessemerizing process, and using the oxide thus formed, when cold, in powdered form for the production of copper salts.

8,776 of 1919 (146,598). G. K. DAVIS, London. Modifications in the process of dearsenicating sulphuric acid by means of sulphuretted hydrogen, whereby the process may be applied to stronger acids than is at present possible.

8,792 of 1919 (146,600). SIR R. A. HADFIELD and W. T. W. WARD, Sheffield. A conveying and screening plant, embodying a grid, all parts of which are caused to move in elliptical paths in relation to a companion grid by connecting it to points intermediate of the length of rods which at one end are driven by eccentrics.

9,021 of 1919 (125,954). SOCIETE BELGE D'OUTILLAGE PNEUMATIQUE (ATELIERS RORIVE), Brussels. Improvements in hammer-drills used particularly in coal mines.

10,333 of 1919 (147,999). A. JACKSON, Hull. The production of an intermediate iron, as a first stage in the manufacture of wrought iron, the object being to decrease the time consumed in the puddling process.

10,530 of 1919 (146,661). W. E. NETTLE, P. SELBY, J. BLYTHE, and J. H. HOLMAN, Johannesburg. Improved method of introducing water through the tool in piston rock-drills.

11,073 of 1919 (146,672). W. E. NETTLE, P. SELBY, J. BLYTHE, and J. H. HOLMAN, Johannesburg. Improved chuck for rock-drills.

13,651 of 1919 (127,595). E. E. BROSIUS, Pittsburgh, U.S.A. A clay-gun for use in plugging the tap-holes of blast-furnaces.

15,686 of 1919 (129,631). E. ODAM, Paris. Centrifugal ball-mill for reducing metals to fine powder.

15,823 of 1919 (147,338). J. H. B. JACOMBS, Birmingham. Improvements in electro-plating apparatus.

27,789 of 1919 (146,772). J., A., & M. GITTINS and G. E. ROBERTS, Wrexham. Improved apparatus for preventing the cage falling when the winding rope breaks.

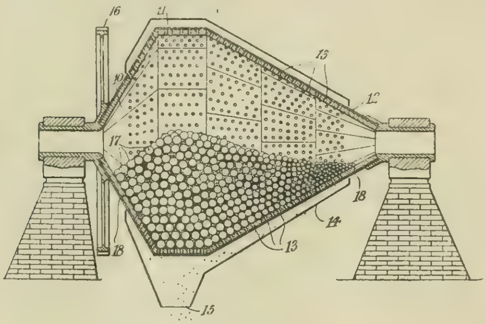
31,908 of 1919 (148,095). P. PESTALOZZA, Milan. Method of electrolytically producing hypochlorites from chlorides.

65 of 1920 (137,325). SCHIELE & BRUCHSATER, Hornberg, Baden. Improved method of casting aluminium in iron moulds.

8,559 of 1919 (125,083). H. P. K. T. NEILSEN, Copenhagen. Method of preparing peat for use as fuel.

10,074 of 1919 (148,615). J. MOREL, Grenoble, France. Improved method of making basic chromium sulphate, suitable for use in tanning.

10,602 of 1919 (148,637). H. W. HARDINGE, New York. In order to secure the earliest discharge of material from conical grinding mills, and also to prevent the cushioning action of such particles while



travelling through the other material to the discharge end, the inventor uses a perforated shell with linings with corresponding perforations. The accompanying illustration indicates the nature of the invention.

12,254 of 1919 (148,659). D. K. MASON, Kenilworth, and F. H. HAVILAND, Bournemouth. Improvements in apparatus used in the electrostatic precipitation of fume.

18,715 of 1919 (148,692). J. G. LEYNER ENGINEERING WORKS CO., Littleton, Colorado. A device for use in drill-sharpening machines, having for its object the prevention of the clogging of the central water inlet during the process of sharpening.

NEW BOOKS, PAMPHLETS, Etc.

☛ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 723, Salisbury House, London Wall, E.C.2.

Manual of Cyanidation. By E. M. HAMILTON, B.A. (Oxon). Leather, octavo, 280 pages, illustrated. Price 18s. net. New York and London: The McGraw-Hill Book Co.

Mr. Hamilton has produced a very excellent little book which he calls a "Manual of Cyanidation." It certainly appears to fulfil its author's object of providing in handy form all the more important data which are needed for testing and working an ore by the cyanide process. The whole work bears the stamp of practical experience. The facts are expressed with clearness and accuracy. In the case of disputed points of theory, the evidence for and against is presented impartially, and logical reasons are advanced for accepting the view adopted by the author. Moreover (what is not always the case in works of this nature), full credit is given for the statements of previous writers in the same field. In a book of this kind a large amount of matter is necessarily inserted which is already to be found in existing works on the subject, but Mr. Hamilton's book presents some novel features which will commend it to the practical worker.

As the present writer was frequently consulted by Mr. Hamilton during the compilation of this book, and is to a certain extent responsible for some of the statements contained in it, particularly in the first two chapters, he is perhaps not well qualified to act as a critic, but he is able to endorse from his own observations some of the statements made by Mr. Hamilton which may appear questionable to some readers.

The first chapter deals in a general way with the theory of the process and the chemical reactions on which it is based. The behaviour of the solvent with gold and silver minerals is explained. Particular attention is given to the action of cyanide on silver sulphide, and experiments are quoted to show that the zinc double cyanide has no solvent effect on this mineral. On the first page attention is drawn to a point commonly overlooked, namely, that thiosulphates as well as thiocyanates results from the attack of sulphide minerals by cyanide. An alkali sulphide is supposed to be formed as an intermediate product, though the present writer has not seen much evidence that this takes place under working conditions in presence of zinc. The occurrence of the reaction involving the formation of thiosulphate will affect the reasoning on p. 9, where it is assumed that all the sulphur of the Ag_2S goes to form KCNS; if this is not the case, the consumption of KCN will be less than that shown, or somewhere between 4 or 5 molecules KCN for every molecule of Ag_2S dissolved.

The causes of the regeneration of cyanide from the double cyanides of zinc and the alkalis during the regular working of the process are also explained, and the suggestion is made that the regeneration may be due to the action of lime in solution, which forms an insoluble zincate, with liberation of an alkali cyanide.

Mr. Hamilton's remarks on the relative solvent efficiency of sodium and potassium cyanides are of interest, and this is a question which has periodically come under discussion in the technical press, but he admits that he has no explanation to offer of the alleged superiority of the so-called "99%" cyanide over pure NaCN. The present writer ventures the following suggestions: (1) Pure NaCN is known to be somewhat unstable, especially if hydrated, and may sometimes have undergone decomposition in transit, or after the cases have been opened (see "Cyanide Handbook," p. 68, also p. 109). (2) The so-called inert substances (Na_2CO_3 and NaCl) used to make up the weight, so that the percentage of CN approximates that of 99% KCN, may in some cases have a beneficial effect on the extraction, or act as protectors of cyanide. He is not inclined to think that the superiority is due to the presence of potassium, as the analyses of the "99%" cyanide seldom show more than 3 or 4% of that element.

In the chapter on testing and analysis of solutions the remarks about free cyanide determination (pp. 20-24) deserve particular attention. The unsuitability of the potassium iodide indicator to solutions containing zinc has hitherto perhaps not been sufficiently recognized by cyanide workers, and the reasons why this indicator should not be used are clearly pointed out. The writer can endorse from practical experience the remarks on p. 22 as to the possibility of obtaining results which can be checked by different operators using method No. 2, and he has himself trained Mexican peons to use the process with sufficient accuracy for practical purposes.

With regard to the determination of protective alkali, Mr. Hamilton has shown (p. 28) that the solution may be accurately titrated for alkali in presence of zinc without addition of ferrocyanide, provided the addition of $Ag\ NO_3$ is stopped at the point indicated by his free cyanide test No. 2.

Methods are also given for determination of zinc, copper, and other constituents of cyanide solutions. The methods are, for the most part, those which have been found most useful in practice, and most of them have been tested and verified at one time or other by the present writer ; many in fact are quoted from those given in his "Chemistry of Cyanide Solutions," sometimes with slight modifications. In the process given for zinc, a slight improvement may be suggested as follows. The precipitate of zinc sulphide is filtered on a double filter-paper, and after thorough water-washing as described, the two papers are separated and placed in different flasks. Each is covered with about 10 cc. of water and then the necessary amount of standard iodine solution run in to give a slight excess, adding an equal amount, exactly measured, to each. The flasks are then stoppered and agitated briskly. After allowing them to remain standing for about 10 minutes, the residual iodine is titrated in each, with addition of a little HCl and starch solution near the finish. The difference of the two readings gives the amount of iodine consumed by decomposition of zinc sulphide. This procedure corrects any possible action of the filter-paper on the standard iodine.

The remainder of the book contains a short summary of the main principles of cyanide treatment. In the chapter on sand leaching will be found illustrations and description of a collecting tank devised by Mr. Hamilton. This apparatus was in use at La Colorada, Mexico, during the present writer's sojourn there in 1910-1912, apparently with satisfactory results.

Considerable space is devoted to the question of slime settlement, and tables are given, furnished by the Dorr Company, containing data for determining the rate of settlement, with a view to calculating the settling area required in any given case. Various types of agitator are described and figured, including the old style mechanical agitator, the Brown or Pachuca tank and the Dorr and Devereux machines. The principles of continuous slime treatment are clearly explained and its advantages and disadvantages pointed out.

On p. 121 there is an interesting discussion of a curious phenomenon often observed by cyanide workers, namely, that after a given pulp has apparently yielded all its soluble gold or silver during the agitation process, a further quantity dissolves during the washing process with weak solution or water. Two explanations are suggested : (1) that this may be due to increased activity of the ions in a less viscous medium, or (2) that the dissolving effect may be only apparent, and due to a liberation of pregnant solution previously adsorbed.

Three chapters are devoted to the discussion of discrepancies between actual and theoretical recovery. This is a trouble which probably every cyanide manager has had to face at some time or other. The various sources of error are pointed out and attention is drawn to the impossibility of securing an exact correspondence between the bullion extracted from the material treated during a given period and that actually recovered in the form of bars during the same period. Mr. Hamilton states, and the writer thinks rightly, that the main causes of these discrepancies are errors in tonnage computation and in sampling of heads. The reasons for discrepancies in assays of slime residues are discussed, together with some of the suggested remedies. This part of the book is worthy of careful study, but there still appear to be points that require clearing up. The present writer is inclined to think that some of the apparent losses in assaying, such as the mysterious loss of gold in drying samples containing aurocyanides, mentioned on p. 154, may be due to the use of unsuitable fluxes or methods. (See "Cyanide Handbook," p. 400).

The chapter on ores presenting special difficulties is of particular interest, as it gives some of Mr. Hamilton's personal experiences in the treatment of such refractory ores. The problem of the so-called manganese-silver ores is one which many metallurgists have tackled in vain. Mr. Hamilton offers a solution, applicable, unfortunately, only in certain cases. It often happens that these ores contain much $Ca\ CO_3$ or other carbonates, in which case the use of SO_2 or of any acid reagent for preliminary treatment is of course impracticable. With regard to chloridizing-roasting, the present writer has found that all ores of this class that he has tested are amenable to that process, and that combined chloridizing roast and cyanide treatment gives higher extractions than any other of the suggested remedies, but it is of course a question of local conditions and costs whether such a method is commercially applicable. Using modern systems of roasting, such as the Holt-Dern process, it seems that the losses of gold and silver should be reducible to small amounts.

The remarks on the injurious effect of arsenic on the extractive power of the solution when zinc precipitation is used are also of much interest, though one would have welcomed some more light on the obscure reactions alluded to on p. 168. Aluminium-dust precipitation appears to offer the best solution in these cases.

With regard to the cyanidation of concentrate there is nothing particularly novel brought forward. Mr. Hamilton points out an effect which most workers on this problem have encountered, namely, that silver becomes more refractory to cyanide after a desulphurizing roast. Referring to the treatment of flotation concentrate, the present writer may mention that some time ago he tested several of the oils commonly used in America as frothing and collecting agents, and found that they had practically no effect on cyanide. The difficulties due to the presence of oil, if they have any real existence, may be caused by some indirect action, such as the absorption of oxygen.

The limitations of the sodium sulphide precipitation process are noted (p. 171). As this reagent is only a precipitant of silver and not of gold, it requires to be supplemented when the latter metal is present, and zinc precipitation is not suitable for this purpose, as the zinc in the soluble double cyanides formed would also be precipitated by sodium sulphide, thus contaminating the product.

In the chapter on precipitation, Mr. Hamilton seems inclined to criticize the equation for zinc precipitation given in the present writer's "Cyanide Handbook." It is perhaps as well to state that this equation is merely intended to represent the final result of the changes involved, and is not incompatible with the other reactions given. It will be seen that if Park's reaction (p. 174) and the first of those given on p. 175 are combined, the present writer's equation results. There may, of course, be a consumption of zinc independently of these two reactions, as shown in the second equation on p. 175.

In discussing the non-accumulation of zinc in solutions, Mr. Hamilton suggests another reason in addition to those given in the "Cyanide Handbook" (p. 300), namely, precipitation as calcium zincate.

An allusion is made to an important new development in cyanide practice, the Crowe vacuum process. This process was suggested by the knowledge that oxygen is prejudicial to precipitation, and the solution is accordingly treated in a vacuum chamber to remove dissolved oxygen, previous to precipitation.

The present writer has made laboratory tests on the process (p. 179) which was in use at Dayton, Nevada, in 1918-1919 for removal of copper and regeneration of cyanide, and obtained satisfactory results.

The remarks about electrolytic precipitation are of interest in view of recent developments of this process. The insoluble anode of antimonial lead, and the arrangement for localizing the anode and cathode reactions are perhaps the most noteworthy points.

In the section on aluminium precipitation Mr. Hamilton describes the process introduced by himself at Divisadero, in which the difficulties due to calcium salts are eliminated by preliminary treatment with sodium carbonate. The calcium is thus precipitated as $Ca\,CO_3$, and at the same time the caustic soda required for the reaction with aluminium dust is formed. The chapter ends with a reference to the use of Na_2S at the Nipissing mill as a substitute for aluminium precipitation, and some remarks on recent developments of charcoal precipitation.

Chapter XI discusses clean-up and melting, and contains various useful practical hints. The Homestake modification of the Tavener process is described.

With regard to the method of sampling bullion bars recommended on p. 209, the criticism might be made that if the original bar showed variation in composition due to liquation, the same would be true, after cooling, of the small sample poured into the assay mould, and there is no certainty that the drill sample taken through the centre of the button would give an average value.

Chapter XII, on laboratory experiments, deserves careful attention, as here again we have the results of Mr. Hamilton's personal experience. The procedure necessary for a correct representation of actual plant conditions is here given, such as wet grinding and screening of samples. Agitation tests of various kinds are described in some detail, and a complete illustration is given of the method of computing cyanide consumption. The method of conducting leaching tests in a vertical pipe whose length equals the depth of the proposed leaching tank is interesting, but as the pipe must be fairly wide, this requires provision of large quantities of material. The test overcomes the errors affecting ordinary leaching tests due to capillarity in the shallow charges used.

The necessity of tests to determine the effect of repeated use of the same solution should be noted, as this is a point frequently overlooked in preliminary investigations for cyanide treatment.

The book ends with a useful collection of tables. Instances are given of cyaniding costs at various places. Under present conditions these latter have little more than historical interest. J. E. CLENNELL.

A Vocabulary of Russian-English and English-Russian Mining Terms and Relative Technical Words. By C. W. Purington, assisted by Gita Toderovich. Pocket size, 128 pages. Price 7s. 6d. net. London: Charles Griffin & Co., Ltd.

With few exceptions the words in this vocabulary are to be found in the well-known standard dictionary compiled by Mr. A. Alexandrof, and this is true also as regards many of the phrases; the remainder of the words or phrases are for the most part either transcriptions into Russian characters, or are simply descriptive rather than technical in the usual acceptance of the term. The foregoing notwithstanding, the vocabulary is well selected, though it might be enarged to advantage. It is handy for the pocket, and should prove a great help and convenience to any engineer or explorer who, having to work in Russia, is already equipped with a slight knowledge of the language; while for those who do not possess such a knowledge the vocabulary would make an excellent companion to Bondar's well-known book.

An unfortunate choice has been made when selecting the paper used, resulting in very bad definition of many of the letters; this is more surprising by reason of the fact that the printers specialize in the printing of foreign languages. The usual practice is for the words in dictionaries to be accentuated, and it is a great pity that the custom has not been adhered to in the present instance, for correct pronunciation of words is usually desirable if not essential. As to mistakes, there are a few, and some of these are such as to suggest that greater care might have been exercised in reading the proofs. The potential importance of a book like the one under review fully justifies, if it does not actually demand, extreme care and infinite patience in preparation. The use of unusual terms such as "spathic acid" should have been avoided. Iron scrapings (page 42) may be "scrap iron," but the converse is not necessarily true, therefore the usual Russian term for "scrap iron" should be given. Azote is nitrogen and not nitre as stated. Hornstone is given as a translation of words that stand for chert. Staneolite occurs where staurolite is intended. On page 51 "centrifugal power" is repeated when "centripetal power" should be used. The expressions as given in Russian to indicate syncline and anticline are obviously wrong, as is evident from the expression given as indicating "hanging wall." When a cross-cut intersects a vein it is said to "strike" that vein, but that does not justify the rendering by the single word "strike" of the Russian words which really mean an "intersection of veins."

Many of us who have travelled in Russia have felt inclined to do or to say something desperate to the clay, especially to that on the hills and during wet weather, but to attempt "throttling" it is useless owing to its slippery character; therefore "throttling" should be removed from page 41 and elsewhere and the word "pugging" substituted. STEPHEN J. LETT.

Malay Self-Taught. By ABDUL MAJID. Cloth, 4s. net. London: E. Marlborough & Co.

The Engineering Inquiry (Electrical and Mechanical). By TOMEY THOMPSON. Cloth, small octavo, 380 pages. Price 7s. 6d. Bristol: J. W. Arrowsmith, Ltd.

This is a new reference book for engineers. Its object is to assist purchasing and selling engineers and merchants in tendering for contracts to fill in the information often missing from the letters of inquiry.

Mathematics for Engineers, Vol. II. By W. N. ROSE. Cloth, octavo, 420 pages. Price 13s. 6d. net. London: Chapman & Hall, Ltd.

This is the second part of a book mentioned in these columns a year ago. It deals with an exposition of the differential and integral calculus and the application of the higher mathematics to engineering problems.

Re-Training of Canada's Disabled Soldiers. By W. E. SEGSWORTH. This book gives an account of the work done under the auspices of the Canadian Government in re-educating returned soldiers. We hope to give some account of the work in a future issue.

Nitrates; Arsenic; Felspar; Fuller's Earth; Magnesite; Chrome; Monazite. Being pamphlets relating to the Mineral Industry of the British Empire and Foreign Countries, published by the Imperial Mineral Resources Bureau. Prices 6d. to 1s. 3d. each.

COMPANY REPORTS

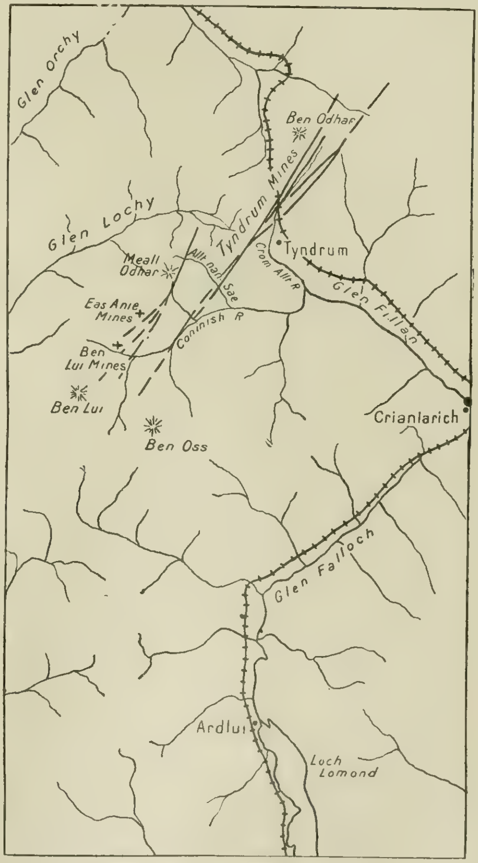
Kinta Tin Mines.—In 1919 this Malayan alluvial tin-mining company treated 1,002,572 cubic yards for a yield of 435·92 tons of tin concentrate, the recovery per cubic yard being 0·97 lb. and the working cost per cubic yard 8·67d. The tin concentrate realized an average price of approximately £148 per ton and the profit for the year was £28,433, which compares with £38,858 for the preceding eighteen months. Dividends amounting to 20%, free of income tax, have been paid for the past year. The directors' report also gives the outputs for the first half of the current year; these total 231 tons of tin concentrate and the gross profits amount to £33,402. The company has a considerable share interest in the Tyndrum Lead & Zinc Mines, Limited, and a second report on this property in Perthshire by Matthew Francis and Son, of Halkyn, is published. They express the opinion that there is every reason to anticipate that the results of further systematic development will prove satisfactory, and that they will ultimately justify the erection of a mill of far greater capacity.

Tyndrum Lead & Zinc Mines.—A second report on these mines has recently been made by J. L. Francis, of Matthew Francis & Son. The first report was not published, but the second was distributed among shareholders last month. The company owning the mines is controlled by Kinta Tin Mines, Ltd. The mines are in Perthshire, Scotland, and in the Magazine for November last we gave an abstract of a report on the district issued by the Geological Survey. We quote Mr. Francis herewith nearly in full.

"Owing to the exigencies as to the labour supply, attention has been primarily confined, in the interval which has elapsed since we first reported, to the erection of a concentrating plant capable of dealing with about 35 tons of ore in 10 hours. At the outset, considerable difficulty was experienced in obtaining satisfactory results, and this entailed certain alterations in the mill. These are not yet completed, but those so far carried out have resulted in great improvements, and the plant may now be said to be working fairly satisfactorily. From samples we took of the crude ore passing through the mill there is no reason to anticipate that the yield will not be as high as estimated, and it should be borne in mind, in this connection, that the richer dumps are not at present being treated. Recent milling returns show a weekly recovery of about 7 tons of lead concentrates assaying about 75% lead with 8 tons of zinc concentrates. The latter contains as much as 21% lead, which, if extracted to a reasonable extent, would increase the lead recovery to nearly 9 tons of concentrates per week. This recovery is being obtained by working one shift a day only, and will of course be materially increased by the employment of a second shift, which was instituted during our stay on the property. The chat mill for cleaning up zinc concentrates is, as at present constituted, inadequate for making a clean separation of galena and blende, and further plant should be provided with the object of making a more marketable zinc concentrate, and at the same time adding considerably to the recovery of galena. This will entail the provision of further tables, etc., for the treatment of slimes and sands generally, and details need not be entered into in this report.

"When we made our first inspection, we were led to understand that an adequate water supply could be obtained from Lochan Bhe, about half a mile to the west of the mill, but, owing to conflicting interests, this source had to be abandoned, and it is found that the alternative supply from various small rivulets is inadequate in periods of drought. These yield sufficient in wet weather, and the disability can be easily overcome by the constitution of a storage dam, on a site which is admirably adapted for the purpose, in close proximity to the mine. Work on this has already been commenced, and an estimated capacity of 5,000,000 gallons can be obtained at comparatively small expense.

"One very satisfactory feature of the operations is the ease in which the tailings, amounting to about 130 tons a week—exclusive of slimes which form only a very small proportion of the whole—are being disposed of at remunerative prices. The demand for this class of material is, owing to the National Building programme and as proved by our experience at other mines, enormous at the present time, and it is likely to



LEAD-ZINC MINES AT TYNDRUM.

continue. No mine is more favourably situated as to the disposal of this product; neither are we aware of one producing anything comparable in quality for concrete making. The siding to connect the property with the Caledonian Railway—the immediate construction of which was contemplated two years ago—has not been put in, and the produce of the mill is conveyed a distance of about half a mile to Tyndrum station by means of horse traction on a tramroad. Storage bins are required at the station for the more economical handling of the tailings, and the construction of these should be taken in hand without delay.

"Owing to a shortage of suitable skilled labour, very little mining work has been done, and the position underground is virtually what it was when we first inspected. We see no reason to modify the favourable opinion we then formed, particularly as many of the blocks of unwrought ground above Nos. 3 and 4 levels, which we previously assumed to be unproductive, have since been proved to contain ore yielding up to 15% of concentrates assaying 75% of lead. Much of the debris packed in the old stopes has also been found to be of payable grade. One important piece of work which has been effected is the clearing out of an old adit level on the south-western slope of the hill, as to which there was some doubt whether it had been driven south-westerly or north-easterly. We inspected this working, and found that the level had only been extended upon a mineralized lode for a distance of from 50 ft. to 60 ft., thus proving that it is virgin for more than half the length traversed in the Tyndrum sett. This is a fact of supreme importance, and it is now possible, with more confidence than heretofore, to recommend that a level should be extended on the lode right through the hill. The forebreasts of both Nos. 3 and 4 levels contain ore, and show promising indications, and after consultation with Mr. Treloar, we agree that, taking all factors into consideration, the most advantageous course to pursue will be to extend the latter. This, as shown by a section of the workings to which we have had access, would give a length upon the lode of about 1,700 ft., and yield an average of about 350 ft. of backs, and judging by the productiveness of the lode in the old mine, should return an enormous tonnage of ore, sufficient to supply a large mill for a great number of years. The extension of this level will by no means exhaust the possibilities of the property, for there will still remain a much greater length and fully as large backs to be developed by the extension of a deeper adit, which can be taken in hand after the results of the development outlined have been ascertained. As stated in our last report, there is every geological reason to assume that the productiveness of the lode will be maintained in the south-westerly extension of existing workings, and it is proved to be highly mineralized where it crosses the River Coninish, in the adjoining property, fully 1½ miles in advance. The ground is hard, and to secure expeditious development, the installation of an air-compressing plant is imperative. This should command immediate attention, as the supply of ore from the dumps is naturally limited, and steps should be taken to open up deposits in the mine without delay.

"In common with most other industries, the company has suffered from a shortage of labour, and the difficulty has in this case been greatly aggravated by a total lack of housing accommodation. Five houses, with a barracks in addition, have already been erected, and it is estimated that at least three more, with another barracks, will be required. Once the housing question is settled, it is anticipated that the difficulties formerly experienced in obtaining labour will be obviated, and in this connection it is satisfactory to note that a good supply has recently been forthcoming.

"We understand that the unissued capital of the Tyndrum Lead & Zinc Mines, Limited, amounts to £22,000, and we consider that, if this be placed, it will provide ample funds for the necessary additions and improvements in the mill, the construction of a storage dam for water, the installation of an air-compressing plant, the development of the mine, and the provision of additional housing accommodation, etc.

"The property possesses natural advantages to a very marked degree, and the fact that pumping and winding expenses can be entirely eliminated to a maximum depth of about 1,000 ft. by adit-level development, is an economic feature of the greatest importance. The lode is of great strength and persistence, of proved productiveness, and is only partly developed. There is every reason, in our opinion, to anticipate that the results of further systematic development will prove satisfactory, and that they will ultimately justify the erection of a mill of far greater capacity. The proximity of the railway makes the disposal of the tailings an assured profitable proposition. We know of no British mine to which the same advantages apply to such a degree, and consider that the success of the undertaking is virtually assured if the programme we have outlined above is adopted."

Tincroft Mines.—The operations of this company, which works the well-known tin mine at Carn Brea, Cornwall, have continued to result in a loss. In the half-year ended June 30 last 16,931 tons of lode stuff was crushed for a yield of 136 tons of black tin, the average extraction being 18 lb. per ton. (In the preceding half year 15,849 tons was milled, and the yield was 20·3 lb. per ton). The average price realized was £36 higher than before at nearly £196 per ton, while working costs averaged 47s. 8d., against 48s. per ton. The loss for the six months was £2,466, as compared with £3,484 for the second half of 1919 and £12,461 for the first half of that year. The report of the general manager, W. Thomas, shows that 555 ft. of development work was done. The directors announce that "owing to existing prices, practically all development has had to be suspended, in spite of the fact that at the bottom of the mine a good section of ground is only waiting funds in order to be opened up."

Bisichi Tin.—Last year's output of this Nigerian alluvial tin mining company was 199½ tons, as compared with 275 tons in 1918, the reduction having been due to labour shortage. In their annual report the directors state that the native labour situation has steadily grown worse; they attribute present conditions to the fact that all Nigerian agricultural products have so risen in value as to offer in their cultivation more favourable opportunities to the native than in his opinion he would obtain in mining work. The company's all-in cost of production last year was £151 per ton, as against £130 in 1918, but the tin concentrate sold realized £242. 16s. per ton as against £219. 10s. per ton. The net profit was £20,139 (against £24,043), and a dividend of 2s. per share (against 2s. 6d.) has been paid, absorbing £20,000.

New Jagersfontein Mining and Exploration.—This company, which operates the Jagersfontein diamond mine in the Orange Free State, and is commonly called "Jagers" for short, has shared in the prosperity which has been enjoyed by the principal diamond producers the last year or two. The export for the twelve months ended March 31, 1920, shows that the quantity of ground washed was 1,768,127 loads, as compared with 1,948,799 loads in 1918–19, but the number of carats of diamonds produced was 147,039½, against 142,313½, the average yield per hundred loads being 9·42 against 8·72. W. J. Pitchford, the general manager, in his annual report, shows that 13,995 ft. of development, all in blue ground, was done during the year, and that at the crushing plants 11·53% of reef was sorted, as against 7·03% in the previous year. The introduction of the eight-hour shift, back pay, increased wages, benefit society, bonuses, and further increases in cost of stores, added to the expenditure during the year. Nevertheless, the profit and loss account shows a credit balance of £728,372, which compares with a profit of £375,224 for 1918–19. Dividends amounting to 12s. 6d. per share have been paid, absorbing £531,250, as against 8s. per share for 1918–19.

The Mining Magazine

W. F. WHITE, *Managing Director.* EDWARD WALKER, M.Sc., F.G.S., *Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LIMITED AND REDUCED, AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938.* Telegraphic Address: *Oligoclase.* Codes: *McNeill*, both Editions.

BRANCH OFFICES: 420, Market Street, San Francisco. 300, Fisher Bdg., Chicago. 2,222, Equitable Building, New York.

SUBSCRIPTION: 16s. per annum (Single Copy 1s. 6d.) including postage to any part of the World.

Vol. XXIII. No. 4. LONDON, OCTOBER, 1920. PRICE 1s. 6d.

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EDITORIAL

ON another page we publish an extensive description of the iron ore deposits on Yampi Sound, off the north-west coast of West Australia. These deposits are now being examined on behalf of the Queensland Government. How the necessary capital to develop these deposits will be raised is at present a question which cannot be answered.

THE Indian Government is establishing a School of Mines and Geology at Dhanbaid, in the midst of the coal-mining district of Bihar and Orissa. Applications are invited for the post of Principal and Senior Professor of Mining, and should be addressed to the Revenue Secretary at the India Office, Westminster. While writing of Indian mining studies, it is opportune to mention that a Mining and Metallurgical Society has been formed on the Kolar goldfield. It seems late in the day to take such a step, but it is evidently the desire of the controllers of the Indian gold mines to encourage discussion of the problems arising out of increased costs and deeper mining.

WE have said on more than one occasion that theorists in world-making and the formation of ore deposits confine their attention almost entirely to petrology, and do not study physical laws or take advantage of the results of the researches of metallurgists and metallographists. From this point of view attention may be drawn to a paper by Professor Carpenter, presented at the recent meeting of the Institute of Metals, dealing with certain phenomena in connection with recrystallization after subjection to pressure and heat. We defer comment until next month, when the question will arise in discussing Dr. Morrow Campbell's paper to be read at the next meeting of the Institution of Mining and Metallurgy.

IN the August issue, attention was drawn to a bundle of absurdities written in an American book about Mr. H. C. Hoover's activities at Broken Hill. An equally ridiculous story connected with mining appears in, of all places, the *Engineering and Mining Journal*, where an E. D. Ward, in the issue of September 19, writes a page of notes headed "Tin a Much-Maligned Metal." We wonder which of the eight editors of our contemporary allowed his judgment to go visiting when he accepted this article. To begin with, what makes the author think that tin is a much-maligned metal? He goes on to tell his readers that tin plate is sheet iron covered with a solution of tin, and that a tin can does not even resemble the metal whose name it has appropriated. He says that tin is found in the British Isles, chiefly in Wales and Cornwall. According to his information, shortly before the war the Germans set up large foundries in England for dealing with old tin cans; also that they offered, at the same period, double the market price for wolfram concentrates. As Professor Moriarty said, "Dear me! Mr. Sherlock Holmes, dear me!"

IN a Letter to the Editor, published elsewhere in this issue, Mr. M. Gregory draws attention to the old Cornish looseness of terminology employed in reporting tin contents. His specific question is: What does a Cornish mine manager mean when he says that an "ore assays 50 to 60 lb. tin oxide per ton"? In answer to this question, a chemist would say that the figure relates to the actual contents of the theoretical SnO_2 as determined by assay. But, as a matter of fact, the ordinary person would say that it probably denotes the estimated amount of tin concentrate obtained on a vanning shovel, the concentrate not being of definite composition as regards Sn or SnO_2, nor representing the total Sn or SnO_2 in the ore. This question raised by Mr. Gregory is an old grievance, which the scientists and the editors have tried to remove; but, unfortunately, as long as promoters, directors, and engineers prefer to talk in vague terms, so long will Cornish nomenclature persist. The only way of conveying an exact idea of the nature of an ore is to give its metallic tin content, with a note of other minerals associated with the cassiterite, the probable percentage of recovery, and the estimated tin content of the concentrate. As regards terms employed, it is advisable to confine the use of the word "ore" to the actual "stuff" mined, and to refer to the products of concentration as "tin concentrate." The term "black tin" is seldom used in the Magazine, for it is a term that leads to many misconceptions. In the first place, printers easily confuse it with "block tin," and, second, except with outcrop ores, the term is only applicable on the *lucus a non lucendo* principle, the dark silicates providing the black tint and not the cassiterite. The loosest of all Cornish practice is to make the word "tin" by itself denote the concentrate caught on the vanning shovel. As for the word "cassiterite," this is a mineralogical term, and should seldom be used in connection with dressing operations. Another term that is often misused, equally by business men and scientists, is "tin ore." It really should be employed only to denote the ore as it occurs in the mine or as it is subjected to the first treatment operation, and never to denote "tin concentrate." Yet we often find mining engineers reporting the saleable output of a mine as so many tons of "tin ore," and geologists referring to the occurrence of "tin ore" in the granite, meaning "cassiterite." The foregoing remarks may serve to draw attention once more to the necessity for precision of expression.

IN our last issue reference was made to the prohibition in the Transvaal of the use of hammer-drills in which air passing through the hollow bit is used for clearing the hole, the reason for this step being that the external water spray is unable to settle the dust efficiently. Some particulars of the tests on which this decision was based are given in a paper read by Mr. H. E. Barrett and published in the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa just to hand. From the figures given by Mr. Barrett it is seen that the fine dust as measured by the konimeter is present to a far greater extent than is considered reasonably safe by the medical authorities, this dustiness being especially noticeable when the down holes are deep. The new regulation is not harsh on the mines or the makers of the drills, for the alteration from dry to wet can be effected with little delay and at no overwhelming expense. The cost would, of course, be trifling if by its means the phthisis levy is substantially reduced. Mr. Barrett also gave some results of tests with drills using the central water flush which is operated in the usual way by compressed air. His figures showed a surprisingly low dust content of the air, and if these are confirmed there would appear to be little reason for interfering with the use of this class of machine. He expressed a doubt, however, as to the representative nature of the tests, and mine managers will endorse his cautious attitude, for experience has undoubtedly shown that there is more dust in the air than is advisable. There should be no insuperable difficulty in designing a method of introducing high-pressure water free from air. In any case trials might be made of the wave-transmission drill, particulars of which were given in the Magazine for June last, for in this machine the central water jet is not actuated by compressed air.

SUGGESTIONS as to the future of London University and the Imperial College, when coming from experienced men, are naturally of interest. Last month Professor H. E. Armstrong gave his views at a reunion of old students of the Royal College of Science, and they merit consideration. He would entirely rearrange the courses of study at University College, the Imperial College, and King's College, bringing the physical sciences to South Kensington, the biological sciences to Gower Street, and arts and economics to King's College, which might well be removed to Kenwood. These three colleges would be federated in an Imperial University of London, but each would be left free to award its own degrees. It may be urged that these proposals would involve sweeping rearrangement, bigger than seems possible at one move, and that the idea of federation and independence as regards the conferring of degrees is self-contradictory. No doubt if the Imperial College joined the present London University, some variation in the curricula in the three colleges would gradually be made, so that the first of Professor Armstrong's proposals would come about gradually, and this advantage of his federation plan would be secured by other means. On the other hand, his second proposal appears to involve a serious element of weakness, for the University would soon fall to pieces if there were no unity of interest as regards the quality of the degrees. However, his proposals merit serious discussion, for thereby some plan acceptable to all parties concerned might be evolved in a calmer atmosphere than that to which we are accustomed when the rivalries of the Imperial College and London University are debated. The proposal involving a consideration of Kenwood in connection with London University is apparently ruled out by the Government's ultimatum to the University Senate to the effect that the decision with regard to its offer of the Bloomsbury site must be accepted without further delay. Indeed, the Senate has practically decided on Bloomsbury.

Technical and Scientific Societies.

During the last year or two there have been changes in the constitution or in the fortunes of a number of societies devoted in greater or lesser degree to subjects in which mining engineers and metallurgists are interested, and there have also been suggestions in the same direction which have not proved acceptable. Proposed amalgamations with other bodies have been resisted by the Canadian Mining Institute and the Australasian Institute of Mining Engineers, and the only sequelæ of the discussions have been the alteration in the names of the societies by the addition of the word "metallurgy," so that the two societies are now known as the Canadian and Australasian Institutes of Mining and Metallurgy respectively. At the same time, the American Institute of Mining Engineers has become the American Institute of Mining and Metallurgical Engineers. In this way the societies interested in non-ferrous metals, their mining and extraction, have come into line as to their names with the Institution of Mining and Metallurgy, which, though not the oldest, may be regarded as the society that has the widest scope and sphere of interest and influence. For ourselves, we did not see any great reason for making these alterations in title, but many have held that the inclusion of a reference to metallurgy serves to emphasize the fact that the membership of the societies is among technical men, and that their objects are not political or social, or connected with trade or the Stock Exchange.

The position of the South African societies continues to cause considerable anxiety among their faithful supporters. It is probable that the scheme for bringing them under one roof, as outlined in the Magazine for July, will test the earnestness of the technical man in South Africa. If the necessary funds can be readily raised, all will be well; but, if not, the organization or even the existence of the several societies will come up for discussion without any possibility of delay. Two incidents have served to draw attention to this matter once more. In the first place, the meeting of the South African Institute of Engineers, at which Mr. James Whitehouse delivered his presidential address, was attended by only eighteen members. Secondly, at the annual meeting of the Chemical, Metallurgical, and Mining Society, a long discussion took place on this subject, one of the most serious points mentioned being the too-general habit of presidents to lose all interest in the society and its welfare after they had passed the chair. It cannot be said that the papers read at the meetings lack interest. The difficulty appears to be to induce members to write them and other members to listen to and discuss them. It has been said that Rand practice has settled down to a standard, and that there are no modifications, improvements, or new ideas to discuss. It might be more correct to say that financial and labour conditions do not encourage expenditure on innovations. As a matter of fact, there was never such need to seek cheaper and more effective ways of conducting mining operations.

In England the only scientific or technical society that is showing signs of decay is the British Association. It is nearly ninety years since this society was founded for the purpose of bringing the claims of science before the public. The idea was to hold a week's meeting every year in some centre of population in order to sow scientific seed among the industries, as well as to afford amateurs the opportunity of rubbing shoulders with the big lions. In later years, after the establishment of other and more specialized societies and of scientific journals, the meetings partook rather of the nature of pleasant conversazioni or excursions, though sometimes they afforded a belligerent professor the opportunity of slaughtering his opponent in public or the theatrical professor to enunciate some thesis that made his hearers' blood curdle. At the present time the chief function of the meetings has partly disappeared owing to science having been popularized in many other ways, and public forums for dispute having been provided by the daily press; while the efficiency of the programmes has been weakened by the multiplication of sections and superabundance of material. It must be confessed that proper supervision of the quality of the papers is not always exercised, and that a large number of poor papers, either studiously vague or consisting of re-hashes, make their way into the transactions. It may be hoped that the present agitation for a reformation of the methods of the British Association may bear some fruit.

Peru and Chile.

The average man knows little or nothing of the causes for the present unrest in the relations of Peru and Chile, or why there are so many delays and difficulties in connection with taking a plebiscite as to the political ownership of the provinces of Tacna and Arica, which are at present under Chilean control. This matter can be best explained by reference to the history of this part of South America.

It is about 400 years ago since Spanish armies under Pizarro took possession, first of Peru, and afterward of Chile. These countries were at that time under the control of the Incas, whose capital was Cuzco, and who had brought the neighbouring races under their control and established a very fair degree of civilization. The Spanish settlers in Peru treated with respect the better classes of the conquered nations, and to some extent the two races have intermingled; but in the more inaccessible regions the aborigines were largely left to themselves, with the result that centuries of Spanish oppression caused a general deterioration. On the other hand, the Spanish settlers in Chile mixed with the native more freely, so that the races have combined into one. The Spanish occupation continued unchecked until the latter part of the eighteenth century, when both settler and native could no longer submit to the exactions of Spain. The first revolt in Peru, in 1780, did not, however, succeed, but the cruelties committed by the Spaniards in its suppression sowed the seeds for other and more determined efforts. A second rebellion in 1810 was equally unsuccessful, and in the same year a rising took place in Chile, which shared the same fate. Release of the Pacific states came eventually from the Argentine republic, which had previously overthrown the power of Spain. In 1817 the Argentine general, San Martin, together with a number of Chilean refugees, crossed the Andes into Chile and took the Spanish army of occupation by surprise. Thus the Chilean republic was established, with O'Higgins as first president. Afterward, San Martin and O'Higgins, aided by British naval officers, proceeded to Peru, as also did General Bolivar, one of the liberators of Colombia, with the result that in 1824 the Spanish hold on Peru was broken, and the last link between Spain and South America was severed.

The boundaries of the new republics were not in any important way different from those of the old Spanish provinces, but Peru was split into two parts, the Peruvian republic consisting of the Spanish Lower Peru, while Upper Peru was reconstituted as Bolivia, so named after Bolivar, its deliverer. The old boundary between Chile and Peru had never been exactly defined, because it was a no-man's-land, a rainless desert supposed to be of no value. This desert, which has since become famous under the names of Tarapaca and Atacama, has proved the cause of sad strife between two nations which should, considering their history, have lived in peace. At the time of the foundation of the republics, the southern boundary of Peru was at Tocapilla, at the 22nd degree of latitude, and thus the province of Tarapaca came within its limits. At the same time the northern Chilean boundary was assumed to be the 25th degree of latitude, the line passing through Paposo. The region between these two parallels of latitude consisted of the province of Atacama, and was given by the New Peru to the new state of Bolivia as a means of access to the sea. For many years all went comparatively smoothly. Peru was peacefully inclined, but its rulers made a mess of finance. Chile showed a more progressive, and also a more aggressive, spirit. No dispute would have arisen about boundaries, however, had the guano and nitrate deposits in the deserts never been discovered. The Chileans first recognized the value of these natural resources, and with the aid of English money led in the development of the deposits. Step by step, they, so to speak, annexed the deposits in Atacama without consulting Bolivia, who was in any case too weak militarily to expostulate. In 1866, Chile took advantage of a

Map showing Position of Disputed Provinces.

war between Spain and the South American republics to negotiate a treaty with Bolivia, according to which the Chilean boundary was moved northward to latitude 24°S, and at the same time Chile was given favourable terms in regard to export duties. Subsequently under this treaty Chile obtained all sorts of concessions, the terms of which, being difficult to interpret or fulfil, led to all sorts of complications. It is commonly said, and is probably true, that the Chilean politicians fooled the shallow-pated Bolivian dictator to a limitless extent over this matter. In 1879 things came to a crisis, and Bolivia called on Peru for aid in combating the demands of Chile. Thus was precipitated a fierce and relentless war between

Chile and Peru. For four years the struggle was bitter, and Chile's campaign in Perú was characterized by wild rapine and murder. When peace was finally declared, in 1883, the provinces of Tarapaca and Atacama were ceded to Chile, while the provinces of Arica and Tacna were provisionally taken over by Chile, their ultimate political disposal being left for decision by plebiscite at some future date. This plebiscite has never come to pass, and cartographers have tacitly marked the two provinces as belonging to Chile. The keenness of President Wilson for a League of Nations prompted the Peruvians to renew their pleas to the United States Government for a consideration of their case, but they have met with as little success as they did when they approached Presidents Garfield, McKinley, and Roosevelt. Chile has agreed, with how much good faith it is impossible to say, to hold the plebiscite without delay, but at the same time is taking active steps to remove forcibly or to frighten away as many Peruvians as possible from the two provinces in question. That is the present state of affairs. What is to be the upshot of it all, we do not care to say; but those who have read the foregoing outline of Chilean-Peruvian history may make a shrewd guess of the Chilean idea.

The Royal School of Mines Register.

The long-promised revised edition of the Register of the Associates and Old Students of the Royal School of Mines was published in August, and the committee who had the matter in hand are to be thanked for providing the public with such a useful record of mining engineers and metallurgists who have received their training at South Kensington. In particular, Messrs. E. B. Lighthill, Ernest R. Woakes, S. J. Speak, and E. T. McCarthy deserve mention for their really arduous labours in collecting all this information. It is to be hoped that the committee will be able in future to keep abreast with these records year by year, and to induce each student as he leaves the School to keep constantly in touch with his fellow associates. Too many old students are indifferent in these matters, apparently considering that no advantage will accrue to them by publishing their records. From their own selfish point of view, they may, perhaps, be right in keeping themselves to themselves. On the other hand, this lack of esprit de corps reacts on the School when its interests and position are at stake. The School has had many fights for due recognition, even for existence, in days gone by, and, to change the metaphor, the end of the furrow is not yet in sight. The Association of Old Students has done well at this juncture to publish the Register; it will have some influence on what is hoped to be the final decision as to the status of the School. The only pity is that more old students did not respond to the committee's invitation, repeated over and over again. The influence of which we speak would have been substantially increased had all the living associates responded as in duty bound.

Readers will remember that the first edition of the Register was published in 1896. With this was incorporated a history of the Royal School of Mines and the Royal College of Science, together with illustrated biographical notices of the professors, written by Mr. Theodore G. Chambers. This volume is now scarce and correspondingly valuable. That we prize our copy highly may be judged by the fact that we do not keep it in the office, for fear some visitor may be smitten by an uncontrollable desire to break the tenth commandment, or even the eighth. The second edition now published contains another history of the School, written by Miss Margaret Reeks, a lady who combines the two qualifications for the work, first of being an expert mineralogist, and second of being the daughter of the first registrar of the School, the late Mr. Trenham Reeks. Her history covers much the same ground as Mr. Chambers', but it is not so full of technical detail and contains a greater number of human touches and references to the lighter side of college life. Her pen pictures of the professors, recording their difficulties and their characters, throw much light on the reasons for a great variety of events. It is naturally impossible for us to deal in detail with Miss Reeks' personal accounts of the many distinguished men who have been connected with the School, but their names are always worth mentioning: Smyth, De la Beche, Forbes, Andrew Ramsay, Hunt, Murchison, and Percy, in the early days; and Le Neve Foster, Roberts-Austen, Bennett Brough, and Judd, in the middle era. All mining engineers should read this history for themselves. As for the professors still with us, Gowland, Frecheville, Truscott, Cooke, Cullis, Carpenter, and Merrett, a future historian will record their good work.

It should be mentioned that the Register is published by the Association of Old Students, and is on sale at the Bookstall of the Imperial College Union, Prince Consort Road, South Kensington, the price to members of the Association being 15s. and to others 20s., in both cases post free.

REVIEW OF MINING

Introduction.—The threatened coal strike has been postponed, and the men's leaders, finding that the Government would not give way, are now advising the acceptance of the terms that are put forward by the Government and the coal-owners. The miners evidently agree with the general public that prices and costs must not be allowed to go higher. In financial and industrial circles, high prices and taxation are causing much anxiety, for it is being found that customers abroad cannot afford the prices charged here for manufactured goods. The labour trouble at Broken Hill appears to be at an end. At any rate the mine-owners have accepted the award of the tribunal appointed by the Government and are preparing to start work again; but no word has yet been received that the men have agreed to the terms.

Transvaal.—The benefits accruing to prosperous mines from the gold premium are characteristically demonstrated by the results at New Modderfontein during the year ended June 30 last. The profit at par value was £1,029,188, and the additional profit arising from the premium was £464,657, representing an increase of no less than 45%. One of the notable features of work at this mine is that the milling returns are higher than are called for by the estimate of reserves. For the last three years the reserve has been reported at about 9 million tons, averaging $8\frac{1}{2}$ dwt., while the yield per ton milled has been over 10 dwt. The reason is that current development is opening up ore of higher value than the average of the reserve, and that mining operations are based on the results of current development. Moreover, it is stated that the actual results of mining have shown the ore to have been of higher gold content than originally estimated.

The developments at Modder East continue to give favourable results. During the year ended June 30 last, the total footage sampled was 17,635 ft., of which 58% was payable, averaging 16·7 dwt. per ton over 26 in. The best results appear to have been obtained at the old Cloverfield shaft, though the ore developed from the two shafts sunk in the new ground is not far short of the same value. The ore reserve was estimated on June 30 at 1,755,400 tons, averaging $7\frac{3}{4}$ dwt. over 55 in., or just double the figures a year ago. As already reported in these columns, milling commenced in April at the Apex plant, 7 miles away. The provision of a mill on the spot, either new or second-hand, with a monthly capacity of 40,000 tons, is being considered by the board.

Two years ago the developments at Consolidated Main Reef were giving poor results, and much anxiety was felt as to the future of the mine. The results during the year ended June 30 last have been much more encouraging, and high-grade ore has been discovered in the bottom levels both east and west of No. 3 auxiliary incline shaft. Mr. E. H. Clifford, the consulting engineer, states, however, that development will have to be continued on the present increased scale for some time in order to put the mine in a sound position.

The West Rand Consolidated, one of the Albu group, has been in a tight corner for funds for some time, as already recorded. In order to strengthen the financial position, the General Mining and Finance Corporation has undertaken to advance money up to £100,000 at $8\frac{1}{2}$%. This loan takes precedence of the debentures, and redemption of and interest on the latter are to be suspended for three years. The company has a share capital of nearly two millions, on which only one dividend was paid, $3\frac{3}{4}$%, in 1909. The property is large, but the ore is of low grade, and much development has to be done in order to maintain reserves.

Last month we recorded the destruction by fire of the surface plant at Knights Deep. The directors have since decided to close the mine. This mine was of very low grade, but as the stopes were wide, operations could be carried on comparatively cheaply until recently, though the cost of pumping was considerable. There has been much caving lately, and many of the best stopes were thereby rendered inaccessible. It is not likely that any reopening will ever be possible. Probably the company will be liquidated and the assets distributed.

Diamond-drilling has been commenced under the auspices of the Coronation Syndicate on Farm Luipaardsvlei No. 10, adjoining Randfontein on the south in the Far West Rand. This farm must not be mistaken for that of the same name on the outcrop of the reef farther north between Randfontein and Roodepoort. The continuation of the reefs south of Randfontein has always provided a geological puzzle, owing to disturbed outcrops, the covering of dolomite and other later rocks, and the incidence of the Witpoortje fault. A number of bores were sunk on Luipaardsvlei No. 10 some years ago, but the results were negative. It is believed that, with the knowledge of the region since obtained, the new bore is more likely to meet with success.

South-West Africa.—A company called Goabeb Tins, Ltd., has been formed locally to acquire tin ground in the Karibib district of South-West Africa.

Congo State.—There has been a strike at the Union Minière mines, and smelting was stopped for a month. Work is now being resumed.

Nigeria.—The latest step of Levers to obtain control of Nigerian trade is the offer to the African & Eastern Trade Corporation to purchase large blocks of shares. This corporation a year or two ago secured large holdings in Swanzy's and Miller's, two of the chief traders in Nigeria and the Gold Coast, but its interests are by no means confined to this part of Africa. As regards the issue of debentures by the Tin Areas of Nigeria to some undisclosed party, the veil of mystery has not yet been lifted.

The Northern Nigeria (Bauchi) Tin Mines company announces that additional capital will be required in order to complete the hydro-electric power installation. The cost of the installation and of the mine equipment has been greater than originally estimated, owing to the continued rise in the cost of labour, material, and transport. The amount required will be nearly £200,000. The directors have not decided how to raise this amount, but probably it will be done by the issue of convertible debentures.

The Jos Tin Area company produced 233 tons of tin concentrate during the year ended July 31, as compared with 267 tons the year before, and the dividend was at the rate of 5%, as against an average of 10% during the previous seven years. The decrease in yield is due to scarcity of labour and the increased clay content of the alluvium. As the end of the property is within measurable sight, the directors are in negotiation for other ground.

Australia. — The Government tribunal that has the Broken Hill labour question in hand has issued its report. The underground men are offered a 44-hour week instead of 48 hours, and the day pay is to be raised from 13s. to 15s. as compared with 20s. demanded. The mine-owners have agreed to this award, but at the time of writing no word has been received as to whether the terms are acceptable to the men or not.

It was announced some months ago that the Broken Hill Proprietary would require additional capital to keep pace with the great expansion of its iron and steel business at Newcastle, New South Wales. A circular has this month been issued, giving an outline of the scheme as finally settled. Another blast-furnace is to be erected, bringing the number up to four, together with the necessary coke ovens; also a by-product plant for the present and new coke ovens, a duplex steel plant, a continuous mill for the production of billets and sheet bars, a duplication of the present rod mill, and a sulphuric acid plant for the supply of acid used in the production of sulphate of ammonia, and at the galvanizing plant. In addition, locomotives and other railway plant, steam shovels, etc., will be required in connection with the enlarged output of ore and finished material. The capital required is £3,500,000, part of which will be raised by the issue of £1,500,000 7% debentures and 420,000 £1 shares at £2. 5s. each. This will bring in £2,400,000; how the remainder will be raised is not stated, but presumably it will come out of current profits.

The silver-lead deposits at Baratta, near Eukaby, in South Australia, 230 miles west of Broken Hill, are attracting attention once more. This district was worked 35 years ago without any important results. Our Melbourne correspondent quotes the Government Geologist's report just published, from which it is clear that more development will have to be done before any definite opinion can be expressed as to the prospects.

The control of the Queensland Government by the labour party has gradually brought that State into an impossible position. The Premier was unsuccessful in floating a loan when he was in this country recently, and as a reprisal he is now threatening to raise a forced loan by diverting profits made in Queensland by English companies.

India.—The Hyderabad (Deccan) Company is about to float a subsidiary to develop the Singareni collieries and the new Kothagoodam coalfield. Additional capital will be raised by the issue of debentures by the new company; these will be offered to the public in India and to shareholders in the Hyderabad (Deccan) Company.

The issue of £1,000,000 debentures by the Burma Corporation has been a complete success. It will be remembered that the whole of these debentures were bought by the National Mining Corporation. On this company offering them on sale to the public the response was ready and the whole issue was placed.

Cornwall.—Our Camborne correspondent gives particulars of the purchase, by the Killifreth company, of the Great Wheal Busy arsenic mine. This mine was worked by Belgians who all died during the war, and their trustees offered favourable terms in realizing the property.

The Dolcoath directors have issued a circular foreshadowing the issue of further capital for the purpose of undertaking the development of the North and South Roskear setts, according to the plan outlined at recent meetings of shareholders in the company. A cross-cut in the direction of this ground is expected to intersect a number of lodes that are worked at present in East Pool, South Crofty, and Tincroft. This would be placed in such a position that the ore discovered could be raised from the Williams vertical shaft. Up to the time of going to press, the business arrangements whereby an issue of new capital could be effected have not been settled.

Devon.—The Dartmoor China Clay Co. has been reorganized in order to provide funds for rearranging and expanding the operations. The company owns the Wotter setts, situated about eight miles north-east of Plymouth and adjoining the celebrated Lee Moor pits. The china clay is at present produced on the spot and carted by road to Plymouth, but according to the new plan a deep-level adit is to be driven and the clay piped to March Mills, on the railway, where new settling and drying outfits will be established. Mr. J. M. Coon has reported on the project, and Mr. Stephen Vivian is one of the directors.

While writing of Dartmoor china clay, it may be recorded that the property and plant of the China Clay Corporation at Redlake, north of Ivybridge, is to be offered by auction this month by order of the Court. This company started under excellent auspices, and why this end should come has not been made clear.

Oil in England.—The Government Petroleum Department has issued a statement giving information as to oil-drilling operations during 1920. The Ironville (Derbyshire) bore No. 1 has been sunk 1,050 ft. to a depth of 3,630 ft., at which point sand in the Carboniferous Limestone series was encountered, giving indications of oil. Ironville No. 2 was sunk 436 ft. to 4,006 ft. At Hardstoft the natural overflow continues steady at 7 barrels per day. The Heath bore is down to 3,758 ft. and is close to the Carboniferous Limestone. Much caving has occurred in the shales, and cementation has been necessary. At Brimington the bore is in the Limestone shales. The Renishaw bore is suspended, as the necessary tools have not come to hand. The Ridgway bore has been abandoned owing to the large flow of water in the Limestone. The Apedale (Staffordshire) bore has been abandoned, and a new bore is to be sunk on another site nearby. At Werrington, also in Stafford, loss of tools has caused great delay. At West Calder (Scotland) the bore is down to 3,844 ft., and at 3,705 ft. a slight show of oil was encountered. The D'Arcy bore, also in Scotland, is down 724 ft. Progress has been slow owing to difficulties arising from a crooked hole.

Canada. — Our Toronto correspondent sends some particulars of the terms offered by British financiers for the supply of additional capital to develop the Davidson Consolidated property at Porcupine. The terms involve the subscription of 1,500,000 shares at 75 cents per share, and the granting, to the subscribers, of options on 2,000,000 vendors' shares at \$1·00 and 1,000,000 at \$1·25, the options to run for two years or until the first 500-ton unit of plant is built. It is said that some difficulty is being experienced in inducing the holders of these shares to grant the options, and that for this reason the scheme may fail.

United States.—Gold-dredging was started at Dayton, Nevada, in September. As long ago as 1850 alluvial gold was discovered in this neighbourhood, and in the early days much gold was extracted. The new venture has been organized by the Gold Canyon Dredging Co. The dredge has a capacity of 5,000 cu. ft. per day, and it is electrically driven.

Mexico.—The new Government has issued a proclamation that mining taxes in arrear are to be cancelled if the companies pay the 1920 taxes promptly. It is believed that many mines long closed down owing to adverse conditions will be reopened as a result of this concession.

The Santa Gertrudis company is about to issue £300,000 debentures, or short notes, with the object of providing capital to complete the equipment of the El Bordo mines and to hasten their development, instead of employing current profits.

The London market in Mexican gold-mining shares has been galvanized into life again by the discoveries at the Esperanza. Since we referred to this matter last month, additional announcements have been made relative to developments. In the first announcement it was stated that for 16 ft. on the 5th level the ore averaged 40 oz. gold and 664 oz. silver per ton over 25 in.; in the second that another 10 ft. had averaged 64 oz. gold and 577 oz. silver over the same width; in the third that a further 21 ft. had given 13 oz. gold and 397 oz. silver. The latest cable states that a fault has cut off the ore. On the third level and in a winze below some excellent ore has been found. These average 2 oz. gold and 30 oz. silver, and more hope is fixed on this occurrence for a large supply of profitable ore than on the spectacular ore below.

Bolivia.—At the meeting of shareholders in Aramayo Francke Mines, Ltd., the chairman gave some particulars of the sales during the nineteen months ended December 31 last, thus supplementing the information contained in the report, to which reference was made in these columns last month. The sales of tin concentrate were 4,148 tons, and of wolfram 230 tons, together with large amounts of copper precipitate, silver ore, and bismuth. The output of tin concentrate during this period was 3,332 tons, obtained from 31,527 tons of ore averaging 7% tin. The production of wolfram was suspended. A new mill is being built for the treatment of the tin-silver ores. As regards developments, the Chorolque tin deposit is now giving indifferent results, but the other mines are doing well, especially the Chocaya, where reserves above water-level have been proved, amounting to 80,000 tons averaging 9% tin and 75 oz. silver per ton.

Spain.—The Rio Tinto Company has issued the usual interim report for the first half of the year. In this it is announced that owing to poor trade and labour troubles no ordinary dividend can be declared for this period. The following is the directors' statement: "The European pyrites markets have not yet recovered from the effects of the war. Quantities being consumed are small, and it will probably be many months before normal consumption is resumed. In the United States market the production of native sulphur material developed during the war is taking part of the pyrites market, and such contracts as can be obtained for pyrites are at very low prices. The cost of coal and iron used at the mines is still very high, but as freights are receding and new sources of supply are being tapped, the directors look to a reduction next year in the present very high costs of materials. The labour situation in Spain generally has been and is very unsatisfactory. The world-wide disturbance in labour, based to a great extent on foreign and political intervention, is the chief source of trouble. For more than two months the company's operations have been almost at a standstill. Till then its workmen were fairly satisfied, as it was supplying essential foods at pre-war prices, and during the last few years had greatly improved social and general conditions of life and had modernized housing. The men recently applied for increased pay in lieu of food benefits, and the directors have acceded to their request, and, so far as can be judged, the men generally are satisfied with the increases granted to cover the extra cost of living. Outside influences, however, are extremely strong, and are preventing the workmen from resuming operations, and, though negotiations continue, no settlement has yet been arrived at." The company has caused the publication in the United States of a statement that these outside influences came from the Bolsheviks. Another side of the picture is given by *The Times* correspondent at Huelva, and by Senor Palacios, the latter of whom was sent by the Spanish Government to investigate. Senor Palacios says that the attitude of the men is due to the unfortunate policy pursued by the board for many years, which has created an atmosphere of hostility toward the company, not only in the Province of Huelva but throughout Spain. He adds that if this policy were altered peace would at once prevail, but that it would be difficult for the company to modify its policy without changing its administrative personnel. The company has replied to these accusations by saying that they are untrue in fact and by implication, and that it does not join in newspaper controversy. We have nothing to add to our comment on Rio Tinto administration, which appeared in the Magazine for November, 1913, except to say that the peaceable nature of the present strike is not suggestive of Bolshevism.

In the August issue we recorded that the Dome Mining Corporation had issued a circular quoting a report made by Messrs. F. W. & R. Payne on its gold-dredging property on the Orbigo river, north-west Spain. This report dealt only with the mechanical problems, as the firm was not asked to check the estimates of gold contents. The company has issued another report this month, made by Mr. Frank M. Lush, of the firm of C. G. Lush & Son. Here again the examining engineer was not asked to make an independent examination of the ground, so all that Mr. Lush is able to do is to quote the results obtained by Mr. T. C. Earl, the company's alluvial engineer.

Spitsbergen.—The Northern Exploration Company has issued a number of statements during the past month to the effect that "a powerful group is bidding for the control of the company," and that "the completion of such a deal might mean an international market for the shares of the company without the sacrifice of British status." We have yet to learn, however, what possessions of the company make the shares worth bidding for.

THE IRON ORE DEPOSITS AT YAMPI SOUND, WEST AUSTRALIA.

By A. MONTGOMERY, M.A., F.G.S.,
State Mining Engineer, West Australia.

We reproduce herewith Mr. Montgomery's description of the Iron Ore Deposits on Koolan and Cockatoo Islands, situated in Yampi Sound, off the northern coast of West Australia.

INTRODUCTORY.—It has long been known to the pearling fleet working the north-west coast of Australia that iron ore occurs plentifully on the beaches of certain parts of Koolan and Cockatoo Islands, which form part of the north side of Yampi Sound, and many of the vessels have been in the habit of visiting these islands from time to time to supply themselves with the ore as heavy ballast. There is some reason to believe that Malay vessels used to visit these islands to get this ore long before it was known by Europeans, but few, if any, traces of their visits are now recognizable and their operations must have been confined to picking up loose ore from the beaches without quarrying from the solid.

Little notice was taken of the deposits until about 1907, when leases for iron ore were applied for on Koolan Island by Mr. P. Kean. These were surveyed in 1908, and at the same time an examination of the deposits was made by Mr. W. D. Campbell, Assistant Geologist of the Geological Survey of Western Australia, whose report, with map, was published in the Annual Progress Report of the Geological Survey of Western Australia for the year 1908. The lessees did very little work upon the iron deposits during several years in which they held them, and in October, 1918, the leases were forfeited and were then taken up again by Mr. John Thomson, of Claremont. Mr. Thomson has had two mooring buoys laid in Yampi Sound close to Koolan Island at very considerable expense to enable vessels to be moored there, and has visited Great Britain to try to get the financial assistance necessary for an undertaking of the great magnitude involved in attempting to put the ore upon the markets of the world.

The survey plan of the Koolan Island leases given on page 205 shows the position of the deposits. The leases on the north and south sides of the island were connected by actual survey, and it is shown thereby that the island is narrower a good deal than it appears on the Admiralty chart (page 205). This Admiralty chart was made in 1914, from surveys by H.M.S. Fantome. The shape of the island is much more correctly shown than on the previous maps, but still much of its outline is only roughly sketched in, and many little details are not shown. The deep inlet on the north side of the island, at the head of which is the outcrop of the north ore-body, for ex-

MAP OF WEST AUSTRALIA, SHOWING POSITION OF KOOLAN ISLAND.

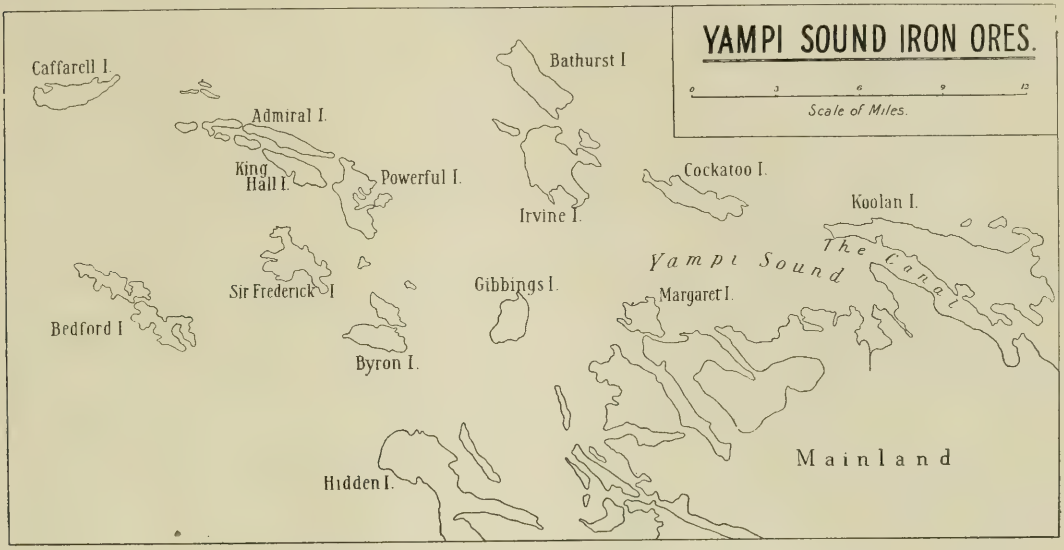
ample, is not shown except as a slight bay. The heights of a number of the largest hills, however, have been determined and charted with a considerable measure of accuracy. More exact surveys of the ore-bodies and the country in their vicinity will have to be among the first working operations undertaken on the island, and will be a work of much difficulty on account of the steep and rugged character of the surface of the ground. The chart gives the latitude of the centre of Koolan Island as about 16° 8′ south, and the longitude as 123° 45′ east. The lease survey makes the position a little more than a mile further north. The islands are well within the tropics, and for about two months of the year the midday sun is actually slightly south of them. For five months of the year, from the end of September onward, the climate is very hot, but for the other seven months it is said to be fairly pleasant. The rains are in the summer, generally from November to March or April, and are often very heavy while they last. The torrents caused by these rains have cut deeply into the surface of the country, carving it into a series of extremely steep stony hills separated by very numerous and steep ravines. Walking across the islands is thus rendered very laborious, the loose stones giving precarious footing and being often hidden by a strong growth of long and exceedingly slippery grass. In many places there are steep cliffs of the harder bands of the country rock, and progress on foot over the islands is quite a formidable enterprise. Though the area of the island is not large, they are, therefore, very difficult to traverse and to survey. Koolan Island is a little over nine miles long, and Cockatoo Island about half as long as Koolan. Both islands are covered with a somewhat sparse growth of small trees and light scrub.

The Admiralty chart is most instructive and valuable in regard to the approaches to the island by way of the sea. It shows that Yampi Sound is an almost entirely land-locked harbour of large extent, the portion known as "The Canal," between Koolan Island and the mainland being excellently protected from all winds. There are good deep-water entrances between Koolan and Cockatoo Islands and Cockatoo and Irvine Islands, while there is an especially spacious and clear one to the north-west between Irvine Island and the Admiral group of islands. The mean spring tide rise is given as 27 ft. At neap tides the H.W.M. is 17 ft. above the L.W.M. of spring tides, but the tidal range is then only seven feet. The tidal currents in this part of the harbour are not very strong, the Fantome's record showing only up to one mile per hour. This is very different from further south in King Sound, where the tidal currents are very strong, and troublesome at times even to vessels of considerable size, the chart showing rates of flow up to seven and eight miles an hour.

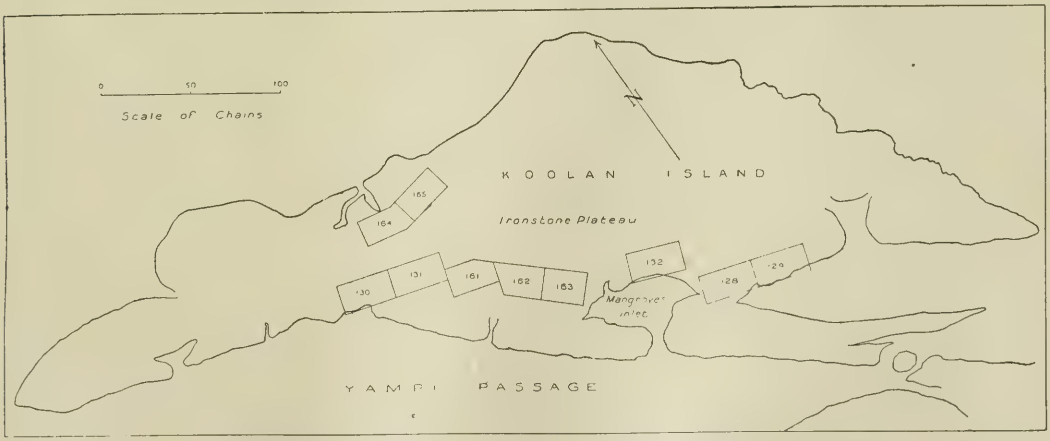
At the east end of the Canal there is a narrow passage about 300 ft. wide, with 20 fathoms of water at low tides, by which entrance or egress may be made to the east of Koolan Island, but this entrance is rather narrow for ordinary use by large vessels. At certain times of the tide the current is very strong in the narrow passage, and it has been suggested that it might be possible to utilize this tidal stream for the generation of electrical power. I understand that this proposition is to be investigated by an American specialist on tidal powers who is expected to arrive in Australia very shortly. The Whirlpool Passage between Hidden Island and Chambers Island, about 15 miles south-west of Koolan Island, should also be investigated in this connection, as very powerful currents are developed there. Among the fiords at the entrance to King's Sound it is probable that there are many other places where strong tidal currents could be utilized for generation of power.

The Admiralty chart shows that the 10 fathom line generally runs quite close in to the shores of both Koolan and Cockatoo Islands, often going up to the base of the steep cliffs on the north side of the former. On the more protected south side of Koolan Island and all round Cockatoo Island the 10 fathom line runs a short distance out from the shore, and there is a tidal shelf which becomes bare at low water of spring tides. Outside this shelf the water deepens rapidly. This condition is favourable for the construction of moles and jetties, and for a certain amount of reclamation of the foreshore, which will be highly convenient for the erection of necessary buildings in connection with the quarrying and shipping operations. The Mangrove Inlet in the south side of Koolan and the large shallow inlet in its south-east corner will be most valuable for disposal of waste from the quarrying operations, which will at the same time reclaim level land for buildings. Care must be taken, however, as will be noted hereafter, to avoid covering up valuable ore recoverable by dredging which probably lies in large quantity in the bottoms of these inlets.

GEOLOGY.—The oldest rocks on the north-west coast of West Australia are those seen in the vicinity of Port Samson, consisting of highly contorted laminated crystalline schists, quartzite, jasper, etc., and often containing large amounts of the oxides of iron, sometimes in veins and layers of considerable size. A great deal of magnetite is often present in them, and the magnetic shoal near Bedout Island, off Port Hedland, is probably a highly ferriferous part of this formation. The more recent strata found along the coast from Port Samson up to Cape Levêque often contain a great deal of iron oxide, probably derived from the erosion of the older pre-Cambrian rocks. East and west of Broome along the coast dark horizontally-bedded iron-bearing strata are very commonly visible, and at the head of Broome jetty there are conglomerates of highly ferruginous sandstone pebbles, cemented by brown oxide of iron. Much of this material contains so much iron that it might



Sketch Map, based on Admiralty Chart.



Sketch Map of Koolan Island, based on Survey Plan.

be considered as a possible source of the metal if better ores were not readily obtainable, as a fairly rich concentrate could be made from it by crushing and magnetic concentration. It would seem, therefore, that the north-west coast must have been naturally rich in iron ore from very early geological times. The Yampi Sound deposits are in sedimentary strata of great age, but still much younger than the old schists seen at Port Samson, and are provisionally referred to the Nullagine series of the Cambrian system. These sedimentary beds must have been derived from still older pre-existing rocks, and as these were rich in iron, it is not unlikely that they were the source from which came the ferruginous concentrations which we now know as the Yampi Sound ore-bodies. These appear to be true sedimentary beds, laid down similarly to the quartzites and slates enclosing them, though quite probably modified and enriched at a later stage by ore-forming reactions. Occasional small veins of quartz and of large flaky micaceous hematite in them give evidence of a certain amount of secondary ore formation. The occurrence of numerous water - worn rounded pebbles in certain portions of the iron beds proves their originally sedimentary character, and there are several hard strata of quartzite outcropping all over the islands in similar manner to the iron ore deposits, and resembling the latter absolutely in their mode of occurrence, though they cannot be taken as anything but beds of the country. Some of these contain a good deal of hematite, as is well seen at the isthmus on Cockatoo Island, and every gradation seems possible to be found in them between pure hematite ore forming the whole bed, down through silicious hematites, to hematitic quartzites and finally, quartzite itself.

The sections on the north side of Koolan and Cockatoo Islands seen from the sea show brown rocks very much iron-stained, usually dipping southerly and underlying the hematitic horizons. The natural sections are plentiful and instructive, and can be well seen by going round the islands with a power launch able to run close in to the shores. The strata are seen to have a general south-south-westerly dip, but to have undergone a great deal of irregular bending and crumpling. The quartzites lying above the hematite deposits show the same sort of crumpling and bending on the mainland side of Yampi Sound also. The ore deposits must necessarily participate in such foldings equally with the strata containing them, which no doubt accounts for the change of dip of the Koolan main ore-body at its eastern end. It is also not impossible that the diverging ore-bodies on the north side of Koolan Island may be in reality one and the same bed, and it might even be, though it is unlikely, that the north bodies on Koolan are really part of the same bed as the south ones, but separated by folding and faulting. It hardly seems possible, however, for the north group at the isthmus on Cockatoo Island to be anything but separate parallel beds lying lower in the series of strata than the main ore-body forming the iron cliffs.

There is a notable change in the general shape of the surface of the country as one passes east of Cape Levêque. Up to this point the land along the coast from Broome is low-lying plain country, little cut into by watercourses, and showing occasional low tablelands, evidently an elevated marine plain, little cut into by rain and stream erosion since its elevation. Probably it is an extension of the Jurassic country seen in the bores for water at Broome, with a capping of much more modern, probably Post-Tertiary, sediments. But near Swan Point the Nullagine quartzites make their appearance, and the whole aspect of the country changes. The coast becomes a chaos of islands, channels, and fiords, and the islands and mainland hills are very steep and rugged and rise up to heights of over 600 ft. above the sea. The channels and fiords are very deep, and the whole relief of the land is that of hard country deeply cut into by torrential erosion. It is impossible to believe that this deep dissection of the surface of this hard country can have been contemporaneous with the slight erosion noticeable in the soft strata west of Cape Levêque, and in all probability it was not, but was mostly done while the latter lay protected under the waters of the sea. It seems most probable that a powerful fault exists running from somewhere near Swan Point through King Sound to the north of Derby, in a more or less south-easterly direction, the Jurassic and Carboniferous country to the south of it becoming somewhat elevated and the Cambrian rocks to the north depressed. The latter region would then present a highly eroded hilly area partly sunk to some 200 to 250 ft. below sea level, constituting the sounds and archipelagos we now find. The soundings shown on the charts quite support this explanation.

From the smallness of the tidal shelves cut round the islands, the probability seems to be that the depression of the fiord country is geologically recent, agreeing with the appearance of the elevated recent marine beds west of Cape Levêque. There seems to be some possibility that the springs of fresh water near the Beagle Bay Mission may be derived from the artesian water-bearing strata which have been tapped by boring at Broome, the springs rising along faults subsidiary to the main one above mentioned.

These physiographical considerations may be of a good deal of consequence in regard to the distribution and position of alluvial iron ore under Yampi Sound, if it should prove that dredging for such ore is a feasible proposition. They would point to the probability that the principal erosion of the iron beds took place from subaerial erosion and not under existing circumstances, and that the fallen ore would be likely to run mainly in the bottoms of old valleys close to the ore-bodies. The concentration of iron gravel on beaches would be only at the places where the sea now touches the foot of the iron cliffs.

The high ironstone plateau found on the main ore ridge on Koolan Island, hereinafter mentioned, consisting of beach-worn hematite boulders and gravel, must belong to a time long before the existing valleys were cut out by torrential action, as the latter cut right into it. These gravels must represent a low level position of the Cambrian country previous to its present deep dissection by rain action, and long previous to the last movement of subsidence which formed the sounds and islands.

IRON ORE DEPOSITS.—On both islands the iron deposits are in the form of huge beds of dense solid steel-grey crystalline hematite, of micaceous structure, interbedded with quartzites and clay slates. As already remarked, they owe their form to having been laid down as beds of sedimentary origin, and have to be considered as such in dealing with their geological occurrence and behaviour, even though it may quite possibly be found as time goes on that the iron-bearing beds have certain characteristics of true metalliferous lodes, and have been greatly altered and modified, since they were first laid down, by some of the migratory exchanges and concentrations of the mineral contents, which are well-known phenomena of lode-forming reactions. From the industrial point of view it is really of little consequence how they were formed, the important fact being that they come to the surface of the ground as thick beds of ore running for long distances on lines striking approximately W.N.W. by E.S.E. and dipping about S.S.W. at angles of 50 to 55° from the horizontal as a rule. In some parts, however, they have participated in the folding and plication of the containing strata suffered by the latter, and have the usual dip reversed or at low angles. As they are not true lodes in the sense in which this word is properly used when speaking of ore deposits, it is best to avoid calling them such, although from a mining point of view the mode of occurrence is quite similar to that of a lode.

It is not yet clear if the iron beds of Koolan Island are identical with those of Cockatoo Island, although from their relative positions it is rather probable that this is the case. On both islands there are two main groups of beds, which we may distinguish as the northern and southern groups. Both groups contain enormous quantities of ore, but on both islands the southern one is by far the most important for immediate ore-production, as it happens, most fortunately for mining, that the iron beds have been uncovered over large areas by natural erosion of the strata overlying them. On the southern side of Cockatoo Island this baring of the iron deposit is most complete, and for about 110 chains in length there is a steep cliff of iron ore, rising to a height of about 300 ft. vertically above high-water mark at an angle of about 55° from the horizontal. A certain amount of ore has fallen from various parts of the face, giving a talus of heavy blocks of ore at the foot of the cliff, and no doubt enormous quantities of ore must have fallen at one time or another and be lying somewhere under the waters of the Yampi Sound. The longitudinal and cross sections on page 209 herewith give a diagrammatic representation of the section shown at Cockatoo Island, drawn approximately to scale. Actual measurements of the widths of the parallel flakes of ore composing the bed showing at the base of the cliffs at the north end on the beach below high-water mark gave a total horizontal width for the ore-body of 172 ft. equal to about 130 ft. measured at right angles to the walls. The iron deposit is completely cut away by the sea at both ends of the cliffs, and disappears under the waters of the Sound, but must be close to the shore of the island. The measurements available are very rough and mostly estimated, but such as they are they justify a preliminary estimate of 13,850,000 tons of ore in these beds at Cockatoo Island, above the high-water mark. There will be no great difficulty, in course of time when such is required, in working the full width of the ore-body down below the tide levels for some distance, greatly increasing the amount of ore that can be won.

On Koolan Island the southern ore-body is not so completely stripped of its hanging-wall country as at Cockatoo Island, but a large portion of it is similarly exposed. Longitudinal and cross-sections belonging to it have been prepared to exhibit the position (page 211). The outcrop of the ore forms the crest of the ridge along the southern side of the island, rising to a height of over 600 ft. above high-water mark in one part. The outcrop can be followed for about 300 chains, the lease surveys enabling this distance to be stated with a fair measure of accuracy. At two points west of the Fantome Trigonometrical Station the outcrop was measured by myself with a measuring tape as 136 and 140 ft. across, apparently all solid ore, equal to a true thickness of the ore-body of, say, 100 ft. At other points the outcrop is so much broken away that the full width of the ore cannot be measured, so lower figures have been taken on the cross-sections in accordance with widths actually seen, although these are probably much less than the full width. Toward the east end, the lode is caught in a plication of the enclosing strata and twisted to dip northerly, and in the easternmost bluff, where the ore-body runs into the sea, the steep face of the bluff shows a great width of ore lying almost horizontally. This bluff was too steep for climbing, but appears to be nearly all ore. For purposes of estimating the quantity of ore in sight the area of this cross-section has been taken at a greatly reduced figure. The available measurements, as at Cockatoo Island, are only very rough approximations, but they serve to enable an approach to be made to fairly definite estimates of quantity, good enough to allow of the vast size of the deposits being appreciated. The estimate works out at 68,850,000 tons above the high-water mark. A very large portion of this can be obtained without expense of removal of any overburden, and it will not be necessary to undertake the working out of the portions flanked with quartzite on the hanging-wall side for many years of operation, during which provision can be made for the extra cost of removing the quartzite when the time comes for this to be required.

The northern ore-beds on Koolan Island run through Mining Leases 164 and 165, apparently joining one another near the west end of 164, and diverging as they go eastward. At the head of the deep inlet shown on the lease plan, the outcrop forms overhanging cliffs 100 ft. high, and the top of a high knob on it a short distance to the west was found to be 182 ft. above high-water mark. The diverging outcrops running easterly form the crest of spurs on each side of a valley up to a height of 470 ft. Both are large outcrops, but the width of ore is not at present properly measurable: probably 40 ft. in width, as given by Mr. Campbell, is an under-estimate. The length of the exposed outcrops is about 50 chains. A very large quantity of ore could be taken from these outcrops without removal of overburden, but this expense would have to be faced here very much sooner than on the southern ore-body. The northern one contains a great deal of first-class ore, but a large portion of it also is of inferior quality, being full of silicious pebbles, forming a coarse conglomerate. This would probably be worth treating by milling and magnetic concentration when the works on the islands had become well established, but would be left untouched as far as possible during the earlier operations. There is a layer of somewhat similar conglomerate in parts of the hanging-wall side of the southern ore-body which will have to be rejected to begin with, though worth treating later on. There are probably not less than 7,700,000 tons of ore in the north ore-bodies above high-water mark.

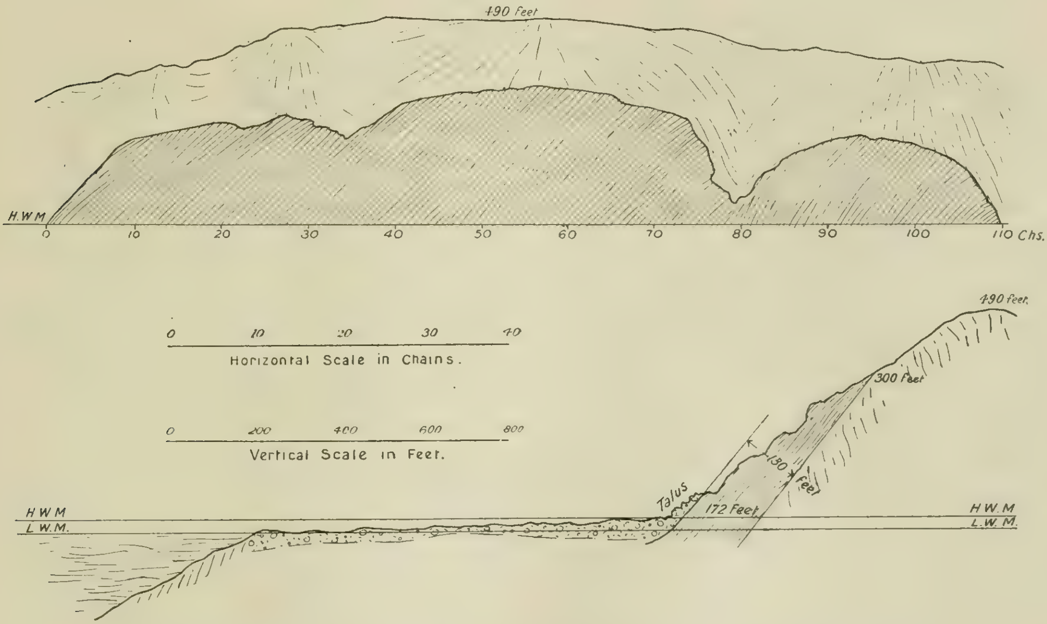
The northern group of ore-beds on Cockatoo Island are well seen at a narrow and low isthmus toward the western end of the island, a short distance west of the end of the southern ore-body above described. Here three parallel beds are seen, which were measured 4 ft. 6 in., 6 ft., and 56 ft. across, dipping S.S.W. about 55°, and apparently fairly good but somewhat silicious ore, and going north to the bay on the north side of the island at this point, four others of 4 to 6 ft. in thickness were crossed in about 100 yards. These, however, appear to be more silicious and too poor to be taken into account at present as ore. There is rather too much valueless rock between the bands of ore on the west side of the isthmus to allow of the hematite being recovered from the smaller beds by open quarrying, and mining them would pretty certainly be too costly. The large bed, however, could be quarried. It rises quickly west of the isthmus to a high knob of 225 ft. above high-water mark, and the outcrop can be seen stretching away to the west end of the island. Going eastward it is seen on the hills up to a height of over 300 ft., but there it seems to disappear. The outcrops extend for about 100 chains. An estimate of 6,900,000 tons of ore above high-water mark seems reasonable for this ore-body.

Bringing the above figures together we get:

Koolan Island South ore-body	68,850,000
North „	7,700,000
	76,550,000
Cockatoo Island South ore-body	13,850,000
North „	6,900,000
	20,750,000
Total	97,300,000

Of course these figures are only to be regarded as such very rough approximations as can be obtained from lengths scaled from the plans, a few barometric heights and taped measurements of widths, and ocular inspection of the outcrops. I have much confidence nevertheless that the quantity of ore is not over-estimated, but the contrary. The object of putting forward such crude figures at all is simply to enable some clear idea to be formed of the great magnitude of the proposition, and its capacity to supply a large output of ore for a long term of years, and also of the extent to which it would justify the expenditure of the large amount of capital required for opening and equipping the quarries and providing the most modern and economical appliances for handling and shipping the ore. The result of the approximate figures is to show that there is a very good prima facie case for considering the Koolan and Cockatoo Island deposits as ranking high among the great iron mines of the world in magnitude. To obtain anything like exact estimates of the ore-reserves, several months of exceedingly arduous survey work would be required, and also a considerable amount of cutting through the ore-bodies at different points by tunnels or bores to ascertain the real widths. Extended sampling and analyses would also have to be carried on to obtain reliable results as to the quality of the ore. In most cases investors proposing to undertake the natural exposures are so complete as to leave no doubt about the size and quality. This is a very unusual and valuable condition of development.

Behind the southern lode station on Koolan Island, an interesting occurrence is encountered at about 470 ft. elevation which gives a good deal of promise of adding considerably to the ore supplies. The crown of the ridge is found to spread out into a small plateau some five or more chains in length and breadth composed of water-worn pebbles of hematite cemented together into a conglomerate by brown oxide



Longitudinal and Cross-Sections of Iron Ore Deposits on Cockatoo Island.

the development of such deposits would be well advised not to conclude any purchase or incur any large expenditure until they had held the property for some time under option, and had tested it fully for themselves by surveys, preliminary mining works, extended sampling, and numerous analyses. In the present instance the very unusual and complete exposure of the ore-bodies in the wonderful sea-cliff sections available makes it possible to dispense with a great deal of such preliminary work, and to attack the proposition with great certainty that both quantity and quality can safely be regarded as already proved. We can actually see and handle the ore-bodies in the cliffs along the whole length and for a depth of as much as 600 ft., and by bores or short tunnels could cut through them wherever desired, but

of iron. On the north side the edge of the plateau forms small cliffs about 15 ft. high, where the conglomerate has been cut away by the erosion of the valley running down to the north inlet. The conglomerate is almost entirely composed of gravel and boulders of good hematite ore, which appear to be pretty easily separable from the brown iron ore matrix. It would be easy to mine the conglomerate, and to recover from it at once a large tonnage of good clean boulders of ore, and the balance could probably be washed clean enough for export by a simple sluicing treatment, using sea water. Certainly the whole conglomerate deposit at this point could be treated profitably in the concentrating mill when such shall have been erected to deal with the poorer ore.

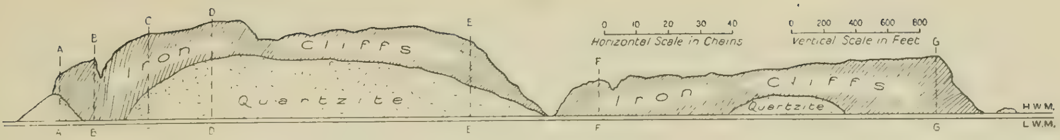
The conglomerate plateau is very suggestive of the probable condition of much of the sea bottom near the foot of the iron-ore cliffs, where hundreds of thousands of tons of hematite have been broken away and buried under the water of the Sound. The Cockatoo Island deposit runs under the sea bottom at both ends of the present cliffs, and most probably more ore has gone into the Sound from these parts of the ore-bed and the fallen-away parts of the visible cliffs than is now remaining. Similarly, on Koolan Island the ore-body runs into the sea at both ends, and has been breached as well at Angus Cove, the Mangrove Inlet, and the deep inlet in the S.E. corner of the island. It is very probable that a vast amount of ore could be recovered from the shallower water near these points by dredging. Close to the foot of the big cliffs it is probable that dredging would be made difficult and perhaps unpayable by reason of prevalence of large and heavy blocks of ore too heavy to be lifted till they have been broken up by blasting, but further out the boulders should not be too coarse for dredging. Nothing can be seen of such gravelly deposits at low tide, as the sea shore is then thickly covered with marine organic growth of shells, corals, and other forms of marine life, which quite prevent any view of the underlying rock. The best test of the possibilities of dredging ore will be obtained when jetties and other harbour works are being built, as then a certain amount of dredging will no doubt be required here and there, and a judgment can then be formed as to whether the bottom would pay for dredging. There can be little doubt that vast quantities of ore could be recovered by dredging and washing of the gravels, but actual trial will be needed before it can be known if the recoverable proportion of ore to waste mud, sand, and stone is such as to justify working. Seeing that dredging can be carried out at a lower cost than quarrying, and that the washing out of the clean ore is a simple process, there seems much likelihood that this method of getting ore may be one of the best available. The possibility should be borne in mind, and in reclaiming the foreshores and constructing harbour works it will be advisable to avoid as far as possible covering up any likely submarine alluvial ore. The probabilities of great development of raising ore by dredging seem to be very well worthy of attention. From physiographical considerations mentioned earlier in this report, it seems likely that in the deeper parts of the Sound the alluvial ore will follow the course of old buried valleys, and will probably lie too deep to be dredged, but in the shallow inlets and on the shelves below the iron cliffs there seems quite a good prospect of being able to recover a very large amount of ore. No estimate of this, however, is yet possible, and no allowance has been made for alluvial ore in the figures of quantity put forward.

ANALYSES OF THE ORES.—The table on page 212 gives the analyses of such samples of Yampi Sound ore as have been recorded by the Geological Survey Laboratory. Nos. 5,196 to 5,201 are of samples collected by myself by taking numerous chips from the outcrops. All the samples are of the nature of grab samples, as close sampling of such enormous ore-bodies would require a great deal of time and labour, which could not be given to the work on any of the occasions on which the islands have been visited by Government officers. Sample 5,196, from the north lode on Cockatoo Island, has proved to be somewhat high in silica, though still of a marketable grade of ore. Sample 5,200 also proved higher in silica than expected, as much of the ore was clearly of high quality. Sample Ob, taken in 1908, was also from this end of the deposit. Further testing at this point is necessary to determine the relative amounts of good ore and poor ore. The ore-bed is much bent at this part, as shown in cross-section G, and in estimating the tonnage in sight, a large reduction was made in the apparent cross-sectional area.

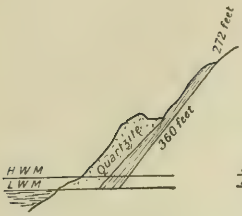
The best ore is so even in quality, according to its appearance, that very little picking out of different grades will be possible during actual work, and it will only be when large consignments are being loaded for export that it will be possible to obtain sampling on a sufficiently extensive scale to ascertain closely at what average percentage of iron the ore can be shipped. On present results and appearances there is much reason to expect that the shipments can be kept up to a grade of 60 to 65% metallic iron for many years.

From these analyses it is seen that the ore is mostly of very high grade, and very free from deleterious impurities. The high percentage of titanium dioxide (TiO_2) in the old alluvial deposit (Sample No. 5,198), near the trigonometrical station, is somewhat remarkable, but all the samples from the solid ore in the main ore-bodies are quite low in this constituent. The phosphorus is, in all but the first analysis quoted, below the limits of 0·05% allowable for acid open-hearth treatment, or 0·10% allowable for acid Bessemer ores.

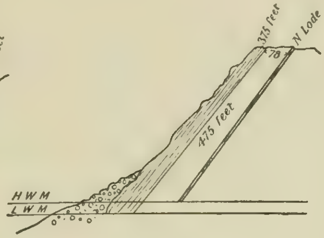
WORKING FACILITIES.—It is very rare to find ore deposits situated so favourably for easy



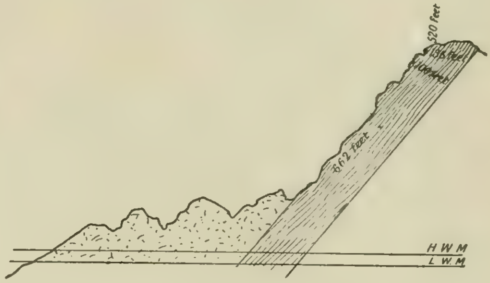
Longitudinal Section of Iron Ore Deposits on Koolan Island.



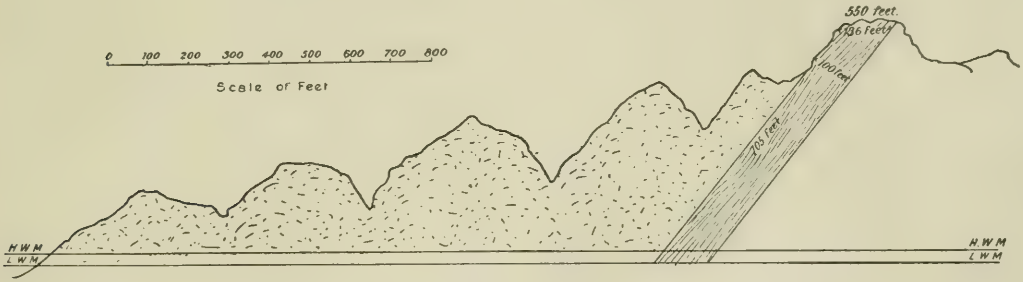
Cross Section at A.



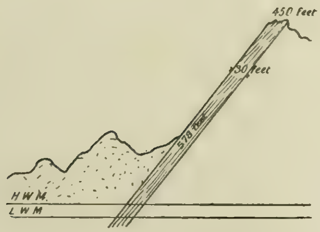
Cross Section at B.



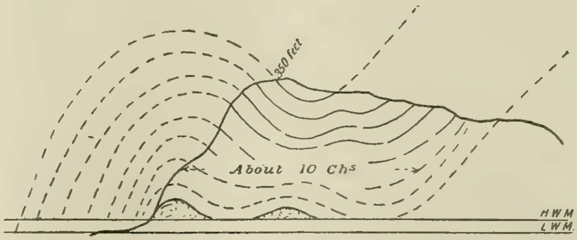
Cross Section at C.



Cross Section at D.

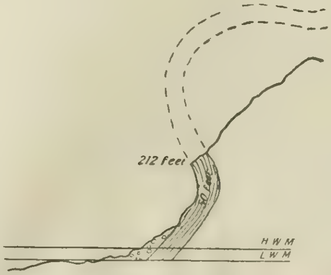


Cross Section at E.



Cross Section at G.

working on a large scale as are those in the beach cliffs of Koolan and Cockatoo Islands. The work will be mostly open quarrying, and quarries can be opened at practically any places along the line of the deposit which may be most convenient. Nature has been most munificent in stripping the ore clear of enclosing rock and preparing it for easy quarrying. The best method of quarrying to be adopted will probably be worked out by experience after several trials of various plans. The ore beds are crossed by numerous strong joints dipping near-



Cross Section at F.

YAMPI SOUND IRON ORES.

Analyses made at Geological Survey Laboratory.

Number	Oa	Ob.	...	5.196	5.197	5.198	5.199	5.200	5.201
Year	1908	1908	1919	1920	1920	1920	1920	1920	1920
	%	%	%	%	%	%	%	%	%
Fe_2O_3	94·97	92·71	97·34	73·86	95·59	87·02	97·53	58·18	98·55
Fe_3O_4	...	...	...	strong trace	slight trace	strong trace	strong trace	slight trace	slight trace
SiO_2	4·16	7·06	1·88	25·55	4·20	2·55	0·52	40·50	0·95
TiO_2	trace	trace	...	0·17	0·35	2·64	0·18	0·37	0·17
SO_3	0·17	0·10	(Not detd.)	0·13	0·12	0·02	0·02	0·05	0·02
P_2O_5	0·14	0·03	,,	0·02	0·03	0·11	0·02	0·02	0·02
$H_2O\pm$	0·20	0·16	,,	0·16	0·17	3·52	0·02	0·24	0·12
Mn_2O_3	...	...	...	*Nil*	0·01	0·06	0·01	*Nil*	trace
Al_2O_3	...	...	...	0·77	0·40	4·63	2·37	1·23	0·66
CaO	...	...	...	0·05	0·04	0·10	0·06	*Nil*	0·05
MgO	...	...	...	*Nil*	trace	0·10	0·03	trace	trace
Total	99·64	100·06	99·22	100·71	100·91	100·75	100·76	100·59	100·54
Metallic Iron.	66·48	64·91	68·14	51·70	66·91	60·91	68·27	41·43	68·99
Sulphur, S.	0·07	0·04	..	0·05	0·05	0·01	0·01	0·02	0·01
Phosphorus, P	0·062	0·012	...	0·010	0·014	0·050	0·009	0·010	0·008
Locality	Koolan Island, main bed, centre	Koolan Island, main bed, East end	Cockatoo Island, main bed	Cockatoo Island, North bed at Isthmus	Koolan Island, North bed above waterfall, North Inlet	Koolan Island, Alluvial ironstone Plateau, near Trig. Stat'n	Koolan Island, main bed top of ridge, near Trig. Stat'n	Koolan Island, main bed East end talus on Beach	Cockatoo Island, main bed talus on beach

ly vertically and running across the thickness of the beds, cutting up the ore into blocks somewhat similarly as the cleat in a coal seam makes coal break out easily in large lumps along lines of cleavage. At present the best method of winning the ore seems likely to be by working down from the tops of the outcrops by heavy blasting with large charges of explosives placed in prepared chambers and tunnels, which will throw down thousands of tons at one firing, blowing out the width of the ore-body clean from the foot-wall. The slopes are so steep that the ore will all fall to the foot of the cliffs, where large lumps can be broken up by sand blasts, and all broken material can be loaded at once into trucks, which can be run by short lines of railway track to loading hoppers on the jetties, or even directly to the ship's sides. The situation is so favourable that the ore can be sent directly from the quarries into ship's holds without intermediate handling. The relative advantage of different systems of carrying out this work will have to be carefully studied by those concerned, so as to get the one most applicable to all the conditions. Steam shovels or electrically driven grabs will probably be most suitable for lifting the broken-down ore from the floor of the quarries, but belt conveyor and other conveyor systems may be preferable at some points. If heavy blasting be resorted to it is obvious that it must be easily possible to withdraw all damageable plant from the base of the cliffs before every firing. The ravines in the quartzite hanging-wall cover on Koolan Island will be found exceedingly useful in catching the heavy falls of ore from the top of the hill. These ravines run almost parallel with the ore-body and the south coast of the island, and are indicated sketchily in cross-section D. Where the cliffs of ore run right down to the sea, as at Cockatoo Island and parts of Koolan, the easiest way to form a working floor for the quarries will be by shooting down a large quantity of ore, which will not require to be removed until the deposits are worked right down to the floor levels. At all these points the tidal shelf shown on the cross-sections will form a natural base on which to build the quarry floors and the moles out to the deep-water jetties.

The proposition is a vast one, and it should be handled from the very first with a view to a large and continuous output of ore by the most economical known methods. Unless a large tonnage of ore be dealt with it will not pay to have expensive handling equipment, and without the best of mechanical equipment there is little hope that costs can be kept down to a figure which will permit of profitable export to distant markets. An output to begin with of about 250,000 tons of ore annually appears to be as low as should be reckoned upon in order to get work done to best advantage. This is equal to quite half of the whole of Australia's at present anticipated output of iron ore, and it will be necessary to secure other markets also to enable it to be disposed of. The British market, however, requires about seven million tons annually, and would be able to take all the Yampi Sound ore offered to it. The shipping side of the proposition will require most able arrangement, so that vessels may be made available at all times for the large tonnage of ore contemplated, at low rates of freight which will enable the ore to be sold profitably, notwithstanding the much longer sea carriage as compared with ores from Spain, and other countries supplying Great Britain's demands. The practicability of the whole proposition will turn upon the shipping possibilities.

PRIMITIVE IRON-ORE SMELTING METHODS IN WEST AFRICA.

By F. DIXEY, M.Sc., F.G.S.,
Government Geologist, Sierra Leone.

The author gives an account, by permission of H.M. Secretary of State for the Colonies, of the Native Methods of Producing Iron from Local Ores in West Africa.

INTRODUCTION.—In the course of investigations which are now being made into the resources of remote countries it is not infrequently a matter of surprise to find native methods of smelting ores, particularly iron ores, still being carried on, and even flourishing in some cases. This is the more remarkable when it is considered that iron tools and implements can very often be carried into such places with but little trouble, and sold at a fairly cheap rate. In certain places, however, native processes still persist, often on account of the primitive man's prejudice against imported material and his belief in the superiority of his own product. That this belief is not always unfounded is shown in the good quality of ancient "Damascus" steel, which was really produced in India[1], and also in that of the metal produced by other Indian workers more than 1,500 years earlier and even now regarded as a perfect steel.[2] As recently as sixteen years ago many of the native smiths of Southern Nigeria regarded the iron manufactured by their own countrymen as much better than imported English iron for the making of hoes and axes[3]; nevertheless they were not above making, for sale purposes, pruning hooks, knives, etc., out of ordinary hoop-iron, just as Sierra Leone natives will use light railway sleepers and similar articles for making tools. This preference is further explained by the fact that the native iron is often of good quality, because of the low content of phosphorus and sulphur in the ores employed, and also because of the efficient dephosphorization brought about by the primitive methods, which involve comparatively low temperatures in the presence of oxidizing fluxes. This dephosphorization may be six times as complete as that effected by modern blast-furnace methods.[4] Moreover in certain cases where labour is particularly cheap and materials abundant, it is possible to produce native iron at a cheaper rate than imported iron; for instance, the output of native iron in the Philippine Islands was 50% greater in 1913 than in 1912, presumably because the native article was cheaper than the imported.[5] In spite of these facts, however, native methods are generally so extravagant in the proportion of fuel consumed and so wasteful in the separation of the metal, that imported iron is considerably cheaper and thus it commands an increasing sale. As an illustration of this it may be pointed out that the native Nigerian iron referred to above cost about six times as much as English pig iron to produce[6], although the native workers in this case possessed more than average skill.

DEVELOPMENT OF NATIVE METHODS.—Native methods of producing iron have been carried on with very little change since the earliest historic times. The industry is considered to have had its origin in Armenia[7], whence it spread to India, where evidence of the manufacture of iron as far back as 2,000 B.C. has been adduced,[8] to other parts of Asia, and to Africa. The earliest record of the making of iron in Africa comes from Egypt, but it was not followed as a regular process in that country before 1,200 B.C.[9] Iron was in use, however, even before any method of extracting it from the ore was known, such iron being produced by chance in camp fires, in forest fires, by lightning, and also from magnetic iron ore, which not only looks like iron but is malleable at moderate temperatures.[10] Moreover, from the earliest historic and prehistoric times meteoric iron has been used by native peoples for implements, ornaments, etc., as has been shown in an interesting paper by G. F. Zimmer.[11] This writer gives details of numerous meteorites that have fallen within late historical times; among those known in West Africa he mentions the case of one near the Senegal River, which in 1716 was fashioned

(1) C. R. von Schwartz, *Journ. Iron & Steel Inst.*, 1901, i, p. 467.
(2) C. R. von Schwartz, *op. cit.*
(3) C. V. Bellamy, *The Ironmonger*, vol. cix, 1904, p. 40. Also *Journ. Iron & Steel Inst.*, 1904, i, p. 41.
(4) F. W. Harbord, *The Ironmonger*, vol. clx, 1904, p. 41.
(5) Report of Department of Mines, Philippine Islands, 1913.
(6) C. V. Bellamy, *op. cit.*, p. 41.
(7) G. Zippelius, *Journ. Iron & Steel Inst.*, 1902, ii, p. 655.
(8) P. Neogi, *Indian Assoc. for Cult. of Sci.*, *Bull.* No. 12, 1914.
(9) Prof. Flinders Petrie, "The Metals in Egypt," 1915.
(10) Sir E. B. Tylor, "Anthropology."
(11) The Use of Meteoric Iron by Primitive Man, *Journ. Iron & Steel Inst.*, 1916, i, p. 306.

by the natives into weapons and even into shallow pots. These meteorites are of course not to be confused with rare examples of iron occurring in the native state.

Instances of the manufacture of iron by natives of West Africa have occasionally been reported or described, and by comparison of the methods employed it is possible to trace at least three stages through which the industry has probably progressed.

Almost the simplest possible method is that described by Capt. A. F. Mockler-Ferryman from near Jebba on the Lower Niger.[12] (9° lat. and 5° E. long.). In this case lumps of ore are thrown on top of a pile of burning wood in a more or less open native kiln ; one native feeds the fire while another works the skin bellows, and both are protected from the heat by a thin mud wall. In the course of two or three hours the metal trickles into a hole beneath the fire and is sold later to the blacksmiths without further treatment.

The second stage, described in detail below, is that still carried on by the iron-workers of Sierra Leone. Here the ore is carefully hand-picked and then fed into a properly constructed furnace ; in due course the metal collects in a well at the bottom of the furnace, while the slag is drawn off by means of a channel near the base. Throughout the greater part of the process, which occupies two to three days, the only draught admitted is a natural one, induced by the construction of the furnace, as described later.

The third and most highly developed stage is illustrated by the process employed by the Nigerian iron workers, some of whom were, sixteen years ago, busily engaged at their trade near the town of Oyo ; this town is situated 35 miles north of Ibadan, which is reached by rail from Lagos in about ten hours. Their furnaces and methods of work were described some years ago by Mr. C. V. Bellamy, Director of Public Works, Lagos, in an interesting and well illustrated paper.[13] These workers calcine and pan their ores before charging them into the furnace, where they smelt them with the aid of fluxes carefully chosen from the slags of previous charges; these fluxes are added and the slags withdrawn at frequent intervals during the smelting, which takes about 36 hours. This slag is drawn off through a hole in the base of the furnace, which is reached from the roof of a short underground tunnel, while the metal remains behind as a pasty mass.

(12) Capt. A. F. Mockler-Ferryman, *Journ. Iron & Steel Inst*. 1893, ii.
(13) *Op. cit*

The presence of this tunnel is interesting as showing a relation between this type of Nigerian furnace and those[14] of the Itumba Hills in East Africa, which are reached by long passages up to 50 yards in length, constructed largely to induce a strong draught.

Furnaces more or less of the type used in Sierra Leone have been recorded also from other parts of West Africa, such as Babela[15] in upper Guinea, and the North West Cameroons.[16] Moreover, they have been known for many years in the Portuguese African colonies, one of which exhibited an entire native iron-making plant at the Pennsylvania exhibition of 1876.[17]

A remarkable departure from the ordinary methods of the African natives is seen in certain parts of Bechuanaland, where the people smelt their ores in small crucibles [18] after the manner of the ancient iron-workers of India.[19] There are, however, no records among the African iron-workers of any form of direct casting, such as practised by a few primitive peoples elsewhere; for instance, the inhabitants of the Philippine Islands have been accustomed for a very long time to cast ploughshares for their own use.[20]

The iron ores used by the different workers vary considerably ; they include lateritic ores, bog iron ores, black sands from streams, and metamorphic ores in the form of grains of magnetite separated from schists by crushing and washing.

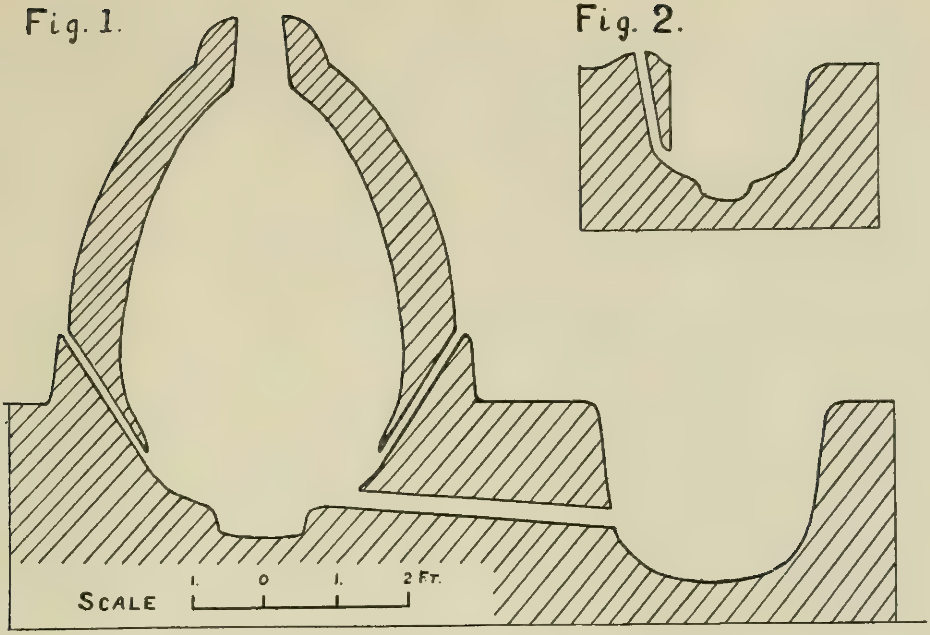
NATIVE METHODS IN SIERRA LEONE.—About the middle of January, 1920, I had the opportunity of visiting certain native iron-smelting works in Sierra Leone, about which no published account has previously appeared, although there are brief references in the literature of the country to the existence of such works. The workings described in the following paragraphs are carried on by men of the Koranko tribe, and are situated on the outskirts of the village of Kalafoia, near Koinadugu, in Koinadugu district; they may be reached by a march of about five days from Kamabai, the terminus of the railway branch line. In a direct line Kalafoia lies about 140 miles N.E. by E. of Freetown. Similar workings are reported from other parts of Sierra Leone, namely, Konno and Kissy.

The iron ore which supplies the furnaces is excavated from a superficial sand formation

(14) J. T. Last, *Journ. Iron & Steel Inst.*, 1894, ii, p. 400.
(15) J. Morrow Campbell, *Inst. Min. & Met., Bull.* No. 67.
(16) *Stahl und Eisen*, vol. xxxi, p. 1,477.
(17) Dr. Douglas, *The Ironmonger*, vol. cix, 1904, p. 41.
(18 *Journ. Iron & Steel Inst.*, 1902, ii, p. 498.
(19) C. R. von Schwartz, *op. cit*.
(20) *Rep. Div. of Mines*, Philippine Islands, 1913.

Fig. 1.

Fig. 2.



DRAWINGS ILLUSTRATING THE NATIVE IRON-SMELTING METHODS IN SIERRA LEONE.

which, near Koinadugu, attains a thickness of about 200 ft. and almost completely buries the underlying crystalline rocks. This sand formation is unstratified, and is typically of a light buff colour. It is almost invariably overlain by a thin cap of ferruginous laterite, which, while rarely exceeding a thickness of one to two feet on the flat hill-tops, may accumulate on valley sides to a much greater depth. The natives extract the ore from such accumulations by means of shallow open workings. The ore, which varies considerably in thickness from place to place, sometimes displays a beautiful pisolitic structure, and at other times occurs as small compact masses ranging up to about eight inches in length and varying from red brown to purple red in colour. A partial analysis, kindly made by Mr. R. W. Atkinson, B.Sc., F.I.C., of Cardiff, of a sample of the ore gave the following results:

	%	
Fe_2O_3	65·76	(Iron entirely in ferric state)
SiO_2	14·71	
TiO_2	0·845	
P_2O_5	0·055	

It will be seen that the percentages of titanium and phosphorus are remarkably low.

Near the site of the iron-ore excavations the iron-workers erect one or two small blast-furnaces for smelting the ore. The furnaces of different localities vary slightly in size, but they are fairly uniform in structure. The following description applies to a typical furnace which was examined near Koinadugu (see Fig. 1). The body was pear-shaped; it stood 6 ft. out of the ground, and was nearly 8 ft. in total length, and about $5\frac{1}{2}$ ft. in diameter at ground level. The walls were 9 in. thick in the upper portions and were made of clay; the aperture used for cleaning out the furnace was filled in with clay and pieces of slag when not required. The roof was fashioned into a well-rounded dome pierced at the apex by the throat of the furnace, which was protected by a stout rim of clay. The mouth was about 8 in. in diameter. Eight sets of air channels, or tuyeres, were placed symmetrically round the lower part of the furnace, each set consisting of four steeply-inclined pipes placed side by side and slightly oblique to the inner furnace wall. The upper ends of the pipes reached the outer air about 1 ft. above the surface of the ground, and their lower ends reached almost to the base of the furnace; they measured 1 in. in internal diameter, and their walls, made of clay, were about $\frac{1}{2}$ in. thick. It should be noted that when the furnace is working and the large aperture in its side is closed up, a very good forced draught is produced by this arrangement of tuyeres, as their total area is only one half that of the throat of the furnace. The pipes were made in the following manner: A mixture of clay and grass fibres, laid longitudinally, was moulded around smooth cylindrical sticks;

when the clay was set, the sticks were removed, and the pipes dried in the sun until they were hard enough to put into position, where their hardening was completed. A small well for collecting the molten iron was sunk into the floor of the furnace, and from near the rim of this well a gently-sloping channel, about 4 in. in diameter, ran through the wall to a second well outside; the channel served the purpose of draining off the slag into the well when the smelting process was complete. The furnace was enclosed in an ordinary native house, from the roof of which a wide central area of thatch had been removed.

To smelt a quantity of ore a large charcoal fire is laid in the furnace and given a good start by the application of country bellows to the air-holes. These country bellows consist of a pair of deep wooden bowls about 9 in. to 1 ft. in diameter, over each of which is fixed circumferentially a loose cover of goatskin; the draught, produced by raising and lowering the covers, which are held one in each hand, is led into the furnace tuyeres by a pipe fixed near the base of each bowl. The intake of the bellows may be at the near end of the outlet-pipe, or in the cover underneath the operator's hand. When a high temperature has been attained, the furnace is fed alternately with baskets of ore and charcoal until about three-quarters full, when it is considered properly charged. Both the ore and the charcoal are previously broken into lumps about the size of walnuts; the ore is thrown in from hemispherical baskets about 9 in. in diameter and the charcoal from baskets twice the size. The furnace is then left to burn for two or three days, after which the condition of its contents is tested by opening the slag channel to let a little slag run out. If the slag flows out quite freely, the smelting is considered complete; if not, more charcoal is thrown in and the furnace heated up once more. When ready, the slag is drawn off into the outer well and the furnace allowed to cool down. The infilling of the large aperture in the side of the furnace is then removed so that the slab of iron can be taken out and broken into small pieces. These pieces are carefully hand-picked, and those which still enclose particles of slag are broken down to a finer grade and melted up afresh in a small furnace, 18 in. deep (see Fig. 2), sunk into the floor of the smelting house. The yield of iron from a single charging of the furnace would probably not exceed 70 lb.; that of the Nigerian furnace described above is considered to be between 70 and 80 lb. as recorded by Bellamy.

The puddling of the iron obtained in this way is carried out by the smith to whom the metal is sold. He effects this at his forge by heating and hammering the metal, the speed of his hammering being increased as the metal becomes hotter. Probably the amount of decarburization so produced is varied in accordance with the kind of tool required.

It is important to notice that the Sierra Leone furnace yields a mobile metal which readily collects at the base of the furnace, and when cold takes the form of cast iron, apparently "white" cast iron; whereas the Nigerian furnace yields only a pasty or spongy mass of metal, termed "puddled" steel[21], which remains in the furnace as the slag is drawn off. This difference in the nature of the yield may frequently be observed on comparing native methods of preparing iron. The more mobile condition of the metal produced by the Sierra Leone workers is probably due to the shape of their furnace, which is proportionally longer than that of the Nigerian workers. This would enable it to offer conditions approximating to those of the modern blast-furnace, in which the metal is first reduced to a pasty state and then, on taking up more carbon, becomes increasingly mobile and collects at the bottom of the furnace.

The Sierra Leone natives use their iron to make knives, matchets, farm hoes, and, in Kissy country, a form of currency known as "Kissy Pennies." These pennies each consist of a thin rod of iron about a foot long, flattened at one end and barbed at the other; they are still good currency in that part of the country and are valued at one penny each.

In conclusion, I have pleasure in acknowledging the assistance I received from my wife, who not only read the proofs of this paper and aided me in making the observations on which it is based, but also shared with me the discomforts of tropical travel.

(21) cf. Analyst's Report in C. V. Bellamy's paper, p. 41.

Colloids.—A discussion on "The Physics and Chemistry of Colloids, and their Bearing on Industrial Questions," is being arranged jointly by the Faraday Society and the Physical Society of London, and has been fixed for Monday, October 25, at the Institution of Mechanical Engineers, Storey's Gate, Westminster. The discussion will be presided over by Professor Sir W. H. Bragg, and it will be introduced by Professor Svedberg, of the University of Upsala. Non-members of the societies may obtain tickets of admission from Mr. F. S. Spiers, 10, Essex Street, London, W.C.2.

THE GEOLOGY OF THE WOLFRAM LODES OF THE WEST OF ENGLAND.

By E. H. DAVISON, B.Sc., F.G.S.

THE HISTORY OF WOLFRAM PRODUCTION.—Wolfram has been a mineral of economic value for about eighteen years so far as its exploitation in the West of England is concerned. Before that time its occurrence in the lodes was looked upon as a disadvantage, and its presence in the concentrates was heavily penalized by the smelters. There is, as a result, a very imperfect record of its occurrence in the older mines. When found in the lode it was carefully avoided, and only noted as an unfortunate defect in the lode or as a mineral occurrence of scientific interest. Its complete separation from the tin by the Oxland process was expensive, and it was not until the introduction of magnetic separation that the dressing of these two minerals could be carried out economically. Since 1903, wolfram has been an important by-product of many tin mines, but in most cases only a by-product, as tin is still usually the chief product of the lodes.

Cornwall produces nearly all the tungsten ore now mined in Great Britain, though small amounts are produced in South Devon and Cumberland. By far the commonest mineral is wolfram $(FeMn)WO_4$, which is practically the only source of tungsten in Cornwall and Devon. Scheelite, $CaWO_4$, occurs in one or two localities, but in too small amounts to be an ore of economic importance.

The following table of output of wolfram ore since 1895 indicates the rise in importance of the mineral. The figures are obtained from Memoirs of the Geological Survey, the Special Memoir on Tin and Tungsten published in 1916 by the Geological Survey, and the year-books of the Cornish Chamber of Mines.

Year.	Long Tons.	Year.	Long Tons.	Year.	Long Tons.
1895	Nil	1903	272	1912	187
1896	43	1904	155	1913	181
1897	125	1905	158	1914	206
1898	313	1906	244	1915	318
1899	86·5	1907	247	1916	356·5
1900	8	1908	220	1917	220·5
1901	18	1909	333	1918	227·5
1902	9	1910	255	1919	254
		1911	245		

GENERAL RELATIONS OF THE LODES.—As is well known, Cornwall and Devon are built up of Palæozoic sediments, which pass from clay-slate of probable Ordovician age in the west through Devonian beds to Culm Measure rocks in north-east Cornwall and south Devon. All are predominantly slaty, and are known to the miners as killas. These sediments are penetrated by five large granite bosses, with a number of smaller ones, each of which is surrounded by a zone of contact alteration which often extends a mile or more from the outcrop. Later intrusions of aplite and pegmatite occur mainly in the granite, and dykes of quartz-porphyry (elvan) of still later date penetrate both granite and slate. Lodes occur both in the granite and in the altered clay-slate around it. There are at least three systems of lodes, and of these the first formed are the chief tin, wolfram, and copper lodes, and have a general strike a few degrees north of east. The three metals are differently distributed in the lodes, the upper parts carrying either predominant copper or wolfram, while tin becomes predominant in depth. Instances of lodes rich in both copper and wolfram are almost unknown. Thus the wolfram occurs in the upper portion of the tin-wolfram zone, and is found chiefly in those lodes which lie close to the granite-slate contact.

DISTRIBUTION OF THE WOLFRAM LODES.—Wolfram-bearing lodes are found in association with each of the granite masses from Balleswidden, near St. Just, to Hemerdon, near Plymouth, but little wolfram has been produced from mines in the Land's End area. The chief areas are as follow:

ASSOCIATED GRANITE MASS.	MINE.	REMARKS.
Land's End	Balleswidden - - -	Abandoned.
Godolphin	Lady Gwendoline & Great Work - - -	Working.
Carn Menelez	South Crofty, Tincroft, East Pool, Peevor, Killifreth, Wheal Busy	Working.
	And many abandoned mines.	
St. Agnes	Cligga Head - - -	Abandoned.
St. Austell	Castle-an-Dinas - -	Working.
	Bunny, etc. - - -	Abandoned.
Bodmin	Treburland, Halvanna, Buttern Hill	Developing or working dumps.
Kit Hill	Kit Hill, Hingston Downs, Hawkmoor, Holmbush, Drakewalls, Bedford	Working.
Dartmoor	Hemerdon - - -	Working.

CHARACTERS OF THE LODES.—The wolfram lodes contain essentially quartz and wolfram. In addition mispickel and cassiterite are commonly associated metallic minerals, and the gangue minerals usually include chlorite and felspar, while tourmaline and fluor-spar are also often present. Less common constituents are copper minerals, pyrite, stannine, and molybdenite, while scheelite, chalybite, scorodite, and iron oxides occur as alteration products. The structure of the lodes is usually very coarsely crystalline, many of them having a structure similar to that of pegmatites. Comb structure is rare, but in the deeper lodes brecciation is fairly common. The lode walls are usually clearly defined, and impregnation of the country rock with wolfram is exceptional. Besides occurring as lodes, wolfram is found as a constituent of pegmatites and greisen bands at several localities.

The order of crystallization of the veinstone minerals appears to be as follows: First, quartz and wolfram, accompanied or preceded by cassiterite if present; then mispickel, stannine, and other sulphides; lastly chlorite and secondary quartz, followed by alteration minerals. When tourmaline or fluor-spar are present, they appear to be among the earlier minerals to crystallize.

Examples of Typical Veinstones.—The simplest wolfram lode worked at present in Cornwall is that of Castle-an-Dinas mine, St. Columb. The lode occupies a clean-cut vertical fissure in tourmalinized clay-slate, and contains coarsely crystallized white quartz with patches of massive wolfram varying from an inch or so to a foot or eighteen inches in diameter. Those two components complete the lode contents, there being no chlorite, tourmaline, mispickel, or sulphides, with the exception of very small amounts of copper compounds. The lode occurs in the clay-slate just above the crest of a granite ridge or apophysis. It meets the granite surface in the lower level of the mine, and is either deflected or pinches out; further development is necessary to prove which is the case. This is an example of a typical quartz-wolfram lode originating from solutions derived from the differentiated granite magma. It is significant that greisen veins carrying wolfram and cassiterite occur in the neighbouring granite.

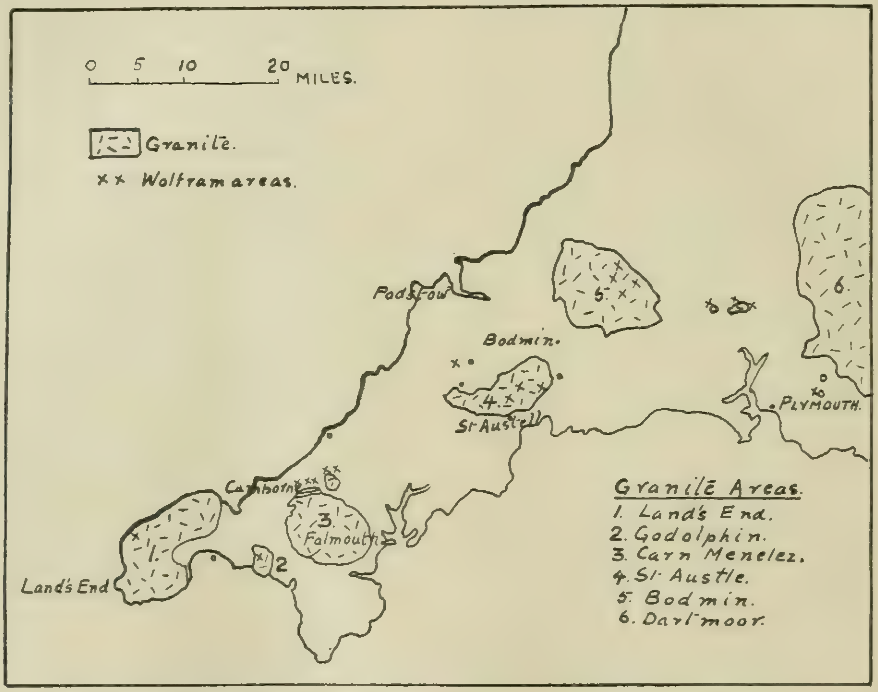


Fig. 1. Map indicating Position of Wolfram Deposits in Cornwall.

At Hemerdon and Kit Hill the veins consist of greisen and pegmatite carrying wolfram and cassiterite, as well as quartz veins with these minerals; mispickel is also present, and molybdenite occurs at Kit Hill. The veins and adjacent granite show the results of pneumatolytic action in the occurrence of tourmalinized rock, and veins, greisen veins, and kaolinized granite. The veins are worked in the superficial portion of the granite mass near the crest of the ridge.

The middle lode at Killifreth mine is filled with clean white quartz carrying wolfram with occasional molybdenite, and vughy quartz containing cassiterite, mispickel, blende, and tourmaline. The lode is worked in the clay-slate away from the crest of the Carn Marth granite mass, but a tongue of granite has been struck 20 fathoms below, and a schorl-rock reef is found in a higher level. In this lode cassiterite is the predominant mineral, wolfram being subsidiary. This seems to be the case with all lodes occurring at depth in the granite, or at what was originally considerable depth in the clay-slate.

The Rogers lode represents a deeper level in the tin-tungsten zone, as the lode is worked from a level situated some 190 fathoms deep in the slate to a level some 270 fathoms deeper, the last 50 fathoms being in the granite. The veinstone is a coarsely crystallized aggregate of quartz, wolfram, mispickel, and chlorite, with cassiterite and fluor-spar and a little tourmaline. The wolfram crystals frequently stand out like the felspars in a pegmatite, of which the whole structure reminds one (see Fig. 2). In parts of the lode the wolfram is seen to have changed more or less completely into scheelite. Microscopic examination shows the crystals to have a centre of unaltered wolfram, shading off outward into scheelite, which is sometimes edged with chalybite crystals.

FIG. 2. VEINSTONE, 190 FM. LEVEL EAST POOL.
Shows Quartz (white), Wolfram (black), changing to Scheelite (pale grey), with Mispickel and Chlorite.
Photo by Surbey, Camborne.

It will be noted that the Rogers lode can be traced from the clay-slate into the granite, and this applies both passing downward and passing from west to east at some levels. It has been observed that wolfram values decrease and tin values increase on following the lode either downward or horizontally into the granite.

A small lode, exposed in a stope in New Cook's section of South Crofty mine, shows porphyritic structure. Idiomorphic crystals of wolfram lie in a coarsely crystalline aggregate of quartz, mispickel, stannine, and smaller wolfram crystals with chlorite (see Fig. 3).

FIG. 3. VEINSTONE FROM STOPE IN SOUTH LODE, NEW COOK'S SECTION, SOUTH CROFTY.
Shows Quartz (white), large phenocrysts of Wolfram (black), Mispickel, Chlorite, and Stannine.
Photo by Surbey, Camborne.

Two other interesting occurrences of wolfram are at St. Michael's Mount and at Cligga Head near Perranporth. In each locality there are bands of greisen running almost vertically and parallel to the margin of the granite which carry cassiterite, wolfram, blende, chalcopyrite, molybdenite, and uranium, with tourmaline, gilbertite, topaz, and white quartz. These greisen lodes show the source of the wolfram to be the granite magma, and this is also borne out by its occurrence in pegmatites.

CONCLUSION.—The wolfram lodes are characterized by predominant quartz; mispickel is a frequent constituent, while cassiterite when present increases in amount as the lode is followed in depth or into the granite, while wolfram decreases. Copper minerals are usually only present in small amount, and tourmaline is often absent or present in small proportions. Fluor-spar is fairly common in the deeper parts of the lode. The lodes are intimately associated with the granite, especially along its contact with the clay-slate. The lode contents have their source in the granite, from which they appear to have been extracted by a process of differentiation similar to that giving rise to pegmatites.

LETTERS TO THE EDITOR

Black Tin.

The Editor:

Sir—Might I suggest that mine operators, prospectors, and others, when reporting in terms of "black tin" and "tin oxide" should state the metal percentage. The metallic content of so-called black tin may vary from 78·6% down to anything. The term "black tin," as often loosely applied, is not necessarily pure cassiterite. As an instance, in the September issue of the MAGAZINE the value of certain ore brought to surface is stated to assay from 50 to 60 lb. tin oxide per ton. Is this pure tin oxide of 78·6% Sn, or is its value judged by the eye on the vanning shovel? Would it not be better to reduce all black tin and tin oxide quotations to, say, a base of 70% Sn or else quote as metal?

M. GREGORY.

St. Day, Cornwall,
September 23.

The Prevention of Corrosion in Locked-Coil Ropes.

The Editor:

Sir—We notice that in your issue for August you print a paragraph describing a type of locked-coil rope in which, it is stated, protection is given to the wires composing the rope by a metallic covering. Without entering into the merits or otherwise of this metallic covering, we beg to draw your attention to that part of the paragraph, in which it is stated that, while it is possible to deal with the question of corrosion in round stranded ropes, the lubrication of locked-coil ropes is a matter of some difficulty. Superficially, this argument would appear to be sound, but we would point out that in all properly constructed wire ropes the bulk of the lubrication is obtained from within, and is not applied externally as the paragraph suggests, this being of a secondary nature, and intended to protect the outer wires where the protective dressing has been removed by friction on pulleys, etc. In round stranded ropes, the main hemp core is thoroughly saturated with lubricant which is gradually squeezed into the strands during the life of the rope, thus overcoming internal friction and corrosion, while in a properly constructed locked-coil rope, the material is thoroughly lubricated by means of an anti-corrosive dressing, right from the initial stages of its construction, with the result that when the rope is finished the internal portions may be regarded as working in a bath of grease, which is of a viscosity suitable to prevent its escape, and is also held in place by the locked sectional wires on the outside of the rope. Under these circumstances it is not necessary to further protect the rope from corrosive influences, and the more real danger, that of internal friction between the members, is also successfully overcome. It will therefore be seen that, from its method of construction, a locked-coil rope is less liable to internal corrosion than other ropes, and the drawbacks mentioned in the paragraph do not obtain when the secondary or external dressing is judiciously applied. It will be well for those interested to carefully consider the above-mentioned points, when reading the paragraph to which we have alluded.

For JOHN & EDWIN WRIGHT, LTD.,
P. A. TAYLOR,
Director.

Universe Wire Rope Works,
Birmingham, September 18.

NEWS LETTERS.

TORONTO.

September 13.

ONTARIO'S METALLIFEROUS OUTPUT.—Returns received by the Ontario Department of Mines for the six months ended June 30 give the total value of metallic production as $22,101,580, as compared with $18,759,829 for the corresponding period of 1919. The list is headed by gold, which was produced to the amount of 277,656 oz., valued at $5,690,504, as compared with 231,729 oz., of the value of $4,666,759. The output of silver was 4,474,322 oz., valued at $5,077,028, as against 5,744,172 oz., of the value of $5,951,362. For the first time since 1903, when the Cobalt silver mines were discovered, the output of gold exceeds that of silver in valuation. Nickel was produced to the amount of 4,854,979 lb., valued at $1,696,687, the output for the corresponding period of 1919 being 5,147,745 lb., of the value of $1,825,347, and the exports of nickel in matte were 9,527 tons, value $5,338,120, as against 7,072 tons of the value of $3,535,915.

PORCUPINE.—The shareholders of the Dome Mines on the 4th inst. ratified the arrangement entered into by the directors for the purchase of the Dome Extension, on which operations have been for some time carried on under the option held by the Dome. Exploration work by means of diamond-drilling indicated the occurrence of large ore-bodies. The acquisition of the Dome Extension property, moreover, removes any apprehension of the veins discovered at depth on the Dome dipping into the Extension, as they appeared likely to do from the formation. The terms of the purchase give the shareholders of the Dome Extension 76,667 shares of Dome stock, being one share for every thirty of Dome Extension holdings.

Diamond-drilling from the 1,250 ft. level of the Hollinger Consolidated has encountered ore at a depth of 2,400 ft. and shown that the same geological formation which obtains on the upper levels is continued to that depth. The shaft is being sunk to tap the vein. The Hollinger has now a working force of about 1,200 men, which is being gradually increased. A number of British miners are expected to arrive this month. The recent payment of an extra dividend of 1% created the impression that the company was about to resume the former scale of dividend payments, but this is officially denied.

The Davidson Consolidated has effected arrangements in England for the sale of 1,500,000 shares of treasury stock at 75 cents per share, coupled with the condition that the purchasers shall have an option on 2,000,000 vendors' shares, 1,000,000 at $1 and 1,000,000 at $1·25 per share, the option to run for two years or until the first 500 ton unit of a mill is constructed. According to this arrangement each shareholder will have to option 50% of his shares to the English interests, and many of them are not disposed to accept the terms. President G. C. Crean states that should the negotiations fall through the company will have no other alternative than to assess the shareholders for the money needed to carry on development and build the mill. At the North Davidson a shaft has been sunk 50 ft. on a vein which is stated to carry rich ore over a width of from 4 to 5 ft. A steam-driven plant has been installed.

The shaft on the Porcupine Keora has reached a depth of 250 ft., and cross-cutting has been started to open up high-grade veins. The Clifton has sunk to 225 ft., and is carrying on lateral work on two levels with satisfactory results.

KIRKLAND LAKE.—The development of the eastern section of the Kirkland Lake district, where many new enterprises have been undertaken, is being watched with much interest. The properties being opened up here include the Bidgood, Crystal Lake, Pinelle Kirkland, Wood-Kirkland, Lebel Ore, and King-Kirkland. They are all situated on a belt of favourable rock formation extending eastward from the producing area of the field. Characteristic features of this section are the great width of some of the veins encountered and the occurrence of showings of visible gold and gold tellurides in close proximity to contacts between the conglomerate and porphyry formations. These conditions are similar to those prevailing in the now productive section of the Kirkland Lake area.

The Lake Shore during July produced $52,424 from the treatment of 1,860 tons of ore, being an average extraction of $28·18 per ton, which is considerably above its general average. Its total output for the year is $339,427. The Kirkland Lake has reduced its operating costs to $6·21 per ton. No. 1 shaft is down about 920 ft., at which depth the rock formation is similar to that on the upper levels. The Hunton Kirkland is continuing the shaft from 40 ft. to the 200 ft. level, where lateral work will be undertaken. The Ontario Kirkland has begun excavations for the new mill, the heavy equipment for which will be brought in over the winter roads. The Wright-Hargreaves has sunk shaft No. 1 to the 400 ft. level, and is stoping ore on several levels in preparation for the completion of the mill. The Wood-Kirkland is installing a mining plant. The shaft is down 40 ft., and the vein shows improvement. The Ontario Government is building a wagon road from the Tough Oakes mine east through Lebel township to Mud Lake.

COBALT.—The leading producing companies are again shipping their bullion, much of which was stored during the depression in the silver market. During the week ended September 10, shipments to the amount of 550,715 oz. were made by the Nipissing and the Mining Corporation of Canada. During August the Nipissing produced silver to the value of $238,919, the total production for the year so far being valued at $2,340,983. Work at the leading mines continues at a normal rate, but a gradual falling off in output is shown. The recently-opened mines, including the Bailey, Colonial, Lumsden, and Oxford-Cobalt, are making good progress with fair chances of success.

VANCOUVER, B.C.

August 31.

THE GRANBY COMPANY.—On August 23, Mr. Justice Gregory rendered a decision in the case of the Esquimalt & Nanaimo Railway (a subsidiary of the Canadian Pacific) v. Wilson & McKenzie, executors of the late Joseph Ganner, in favour of the plaintiff, thereby taking away the title to the Cassidy colliery, at Nanaimo, from the Granby Consolidated Mining, Smelting & Power Company, which bought the coal lands from the Joseph Ganner estate. Joseph Ganner received the coal lands under the Settlers' Right Act, having been in possession of the surface rights prior to the construction of the Esquimalt & Nanaimo Railway. The Granby company purchased the property from the Ganner estate, and applied to the Provincial Government for a Crown grant of the property, which was given to them. On the strength of this the Granby company developed and equipped the property at a cost of over $2,000,000. The Esquimalt & Nanaimo Railway Co. applied to the courts to have the Crown grant made null and void, with the result as stated, claiming that the Dominion Government had granted the land to it in part consideration for constructing the railway. The case will be fought to the ultimate court of appeal, and, in the meantime, arrangements have been made by which the Granby company will continue to work the property until the final settlement. The Granby company bought the coal lands at the time of the strikes at the Crow's Nest Pass collieries in order to render itself independent of outside collieries for coke for its smelter. Besides developing the colliery, which now is producing 500 tons of coal daily, the company built 30 by-product, coke ovens at Anyox on the mainland. Under the new management at the copper mine and smelter, at Anyox, the Granby company produced 2,400,000 lb. of copper during July, against 2,079,000 tons in June. The tonnage of both coke and flux is said to have been reduced. The company now is contemplating the erection of a concentrating plant with a capacity of 2,000 tons per day at its mines at Hidden Creek, with the view to concentrating and sintering the ore before smelting it.

THE CANADA COPPER CORPORATION, which has developed an ore reserve of more than 11,000,000 tons at Copper Mountain, in Similkameen district, erected a 2,000-ton concentrator at Allenby, and is constructing a spur railway to the mine and concentrator from Princeton, has been obliged to reorganize in order to complete the work. The corporation has had a lot of bad luck. The plant should have been finished last autumn, or at any rate, early in the present year, but, owing to strike after strike, the work has dragged on. In the meantime the cost of supplies and labour has increased, and has so far caused an increase on the preliminary estimate of half-a-million dollars. This amount has been underwritten, and the shareholders have been given the alternative of paying 50 cents per share and receiving share for share in the new organization, or of exchanging ten shares of the old stock for three of the new.

THE IMPERIAL OIL COMPANY has struck a flow of about 10 barrels per day in a well north of Great Slave Lake, in the Mackenzie River basin. While the discovery, of course, is not of great commercial value in itself, it is considered to be the possible harbinger of better things to come. Oil was found in three strata, at 80, 200, and 425 ft. respectively. The find is of interest, too, from the fact that the bore was sunk on the advice of S. E. Slipper, of the Canadian Geological Survey. Mr. Slipper said: "Northward of the granite spur extending westward between Athabaska and Great Slave lakes another embayment of the ancient sea is encountered. The deposits in this embayment show a sedimentation somewhat similar to that in Manitoba, but as they are not marked by great thicknesses of Cretaceous shales and as the basin was not so greatly deepened by continental stresses, exposures farther from the fluctuating margin are found, and the Devonian section includes the petroliferous beds that are absent from the exposures in Alberta and Saskatchewan. These beds can be reached by the drill over a large area, and the probing for oil presents consequently many more chances of success than is expected of the Devonian basin lying beneath the Cretaceous rocks to the south." The oil found is said to have a low specific gravity and high petrol content.

NORTHERN BRITISH COLUMBIA.—Four days of continuous rain following right after previous heavy rainstorms that had saturated the ground has done considerable damage in the northern mining sections of British Columbia. The Algunican Development Co. had only just completed repairs to the old Portland Canal short line, up the Bear River valley, when the storm came and demolished every bridge, four in all, over the creeks tributary to Bear River. The Algunican company repaired the line to enable it to get supplies to the Fitzgerald group of claims, which it has under option. Cables have been stretched across the creeks, and these will enable some supplies to be taken across. Next to the Premier Mining Co., the Algunican company, which is a Belgian concern, is the biggest employer of labour in the district; it has a number of properties under bond and is actively developing the Spider, Northern Light, and Fitzgerald groups of claims. The storm caused considerable damage to the Dolly Varden railway, and traffic had to be suspended for a week while repairs were being made. Trains are moving again now, and the mine is shipping about 150 tons of ore daily. The tunnel at the 675 ft. level at the Premier mine has cut the ore-body, thus establishing its continuity to that depth, at any rate. It will take some time to determine the width and length of the ore-shoot at this point, but the quality of the ore is said to be similar to that found in the upper workings.

SLOCAN.—Trouble between the mine-owners and the One-Big-Union in the Slocan district continues to drag on, and already it has been the means of considerably curtailing output. One almost regrets at times that the more vigorous methods common in the United States under similar conditions do not prevail in Canada. This pernicious body, the O.B.U., has done nothing to improve conditions for the working men; it has driven many of them to other places, where it is not uncommon to find them working at a lower wage-scale than prevailed at the Slocan camps. None of the mines in the Slocan are absolutely closed, but nearly all are working short-handed.

MELBOURNE.

August 5.

YAMPI SOUND IRON.—Queensland State Government experts who recently visited the Yampi Sound iron deposits, Cockatoo Island, West Australia, have submitted a preliminary report to the Minister of Mines. They point out that their final report could not be presented until the drill reports were received, analyses made, and the results considered, which, owing to the limited means of communication with Yampi Sound, it was expected would occupy until the end of August. Consideration of the data obtained on all necessary questions other than diamond-drilling and the preliminary formulation of the experts' recommendations would fully occupy the intervening time. Before their departure from the island the whole of the drilling plant was landed and set up practically ready for starting, and arrangements were made for the drilling decided upon, to be completed by the end of July. The party left Brisbane on May 29, and all possible assistance was afforded them by the Mines Department of Westralia. Leaving Broome on June 22, Cockatoo Island was reached on June 24. Six days were spent in examining the island from the various points of view with which they were concerned, and obtaining all necessary data as to the extent and quality of the iron ore deposits, the practicability of stoping the ore, settlement questions, and other matters in connection with the establishment of the mining works on the island. A rather anxious day was spent after arrival in locating a water supply for the diamond-drill men, but this was eventually found on the mainland, about 12 miles from the island; there were also several small rock holes, with a smaller supply, on the island itself.

GORDON RIVER OSMIRIDIUM.—Mr. A. McIntosh Reid, Assistant Government Geologist for Tasmania, who has of late been investigating the osmiridium deposits of what is broadly called the Gordon River district, in south-west Tasmania, has issued a preliminary report thereon. He more definitely indicates the locality which he visited as the country between Fitzgerald railway terminus and the Serpentine River. This region embraces the Styx, Weld, Florentine, Serpentine, and Boyes River areas, in all of which occurrences of this metal are known. The route followed on the expedition is that known as the South Gordon. From Mayne's farm, six miles beyond Fitzgerald railway station, the track has a general westerly course for 36 miles to Serpentine valley, thence northerly for ten miles to the Gordon River crossing. It passes along the foothills of a great series of mountain ranges, which divide the watersheds of the Derwent, Huon, and Gordon rivers. The various geological formations of the district are fully described in Mr. Reid's report, together with their mineral contents, but the author states that in the Serpentine River area false identifications are shown in old exploratory charts, green micaceous schists having been mistaken for serpentine, and titaniferous iron-ore for osmiridium. Mr. Reid proceeds: "Although these reports could not be substantiated, it has been found that a belt of serpentine extends from the Gordon River for a mile in a north-westerly direction along the eastern flanks of Hamilton Range. This is a discovery of great importance and is worthy of close investigation. At the time of this visit the river was at full flood and unfordable, and consequently the area could not be examined. Osmiridium, with its parent serpentine, has been observed by prospectors on the east bank of the Boyes River, west of Denison Range. The grain-size is small and the material is flaky, and consequently unsuitable for the chief commercial uses for which it is in such great demand. From the foregoing account it may appear at first sight that the results of the expedition are somewhat disappointing, and that this region is never likely to become an effective producer of osmiridium. The paucity of osmiridium here compared with the rich concentrations in the great fields in the Western Districts is directly proportional to the sizes of the serpentine outcrops. Moreover, enormous masses of serpentine in the latter localities have been removed by erosion and their content of osmiridium collected in the beds of adjacent streams, whereas in this locality the denudation of the intruded formations has not been carried deep enough to expose large areas. The Hamilton Range outcrop is the largest and most important, and this area offers considerable inducement to prospectors."

THE QUEENSLAND GEM INDUSTRY.—The Queensland Government is now giving some attention to the much-neglected gem industry in the Northern State. While in Central Queensland recently, the Minister for Mines visited the gem fields, spending two days at Ruby Vale and Sapphiretown. Mr. Jones stated, on his return to Brisbane, that a large deputation of gem miners had waited upon him and presented a set of resolutions asking that the Government should take over the marketing and sale of the sapphires. The prices were high in March, but latterly there had been a slump, and it was felt that the industry might be stabilized by the Government taking control to the extent suggested. He had promised to consider the matter and to submit it to the Cabinet. Mr. Jones added that certainly something should be done to stabilize the industry, but the position bristled with difficulties, and it also had to be determined whether State control of the marketing of the gems or open competition would be the better for the miners. If the State were to succeed in any such action it would be essential that all the claims should be registered and the whole thing properly systematized, for it would be necessary that the full production should be accurately known, and that complete returns should be furnished monthly. There was no such full registration now. For instance, the figures relating to last year set out that 1,400 men at the Ruby Vale and Sapphiretown fields produced a value of £44,700, but he was satisfied that the value was nearer four times that amount. He had had his attention drawn to a washing plant, the invention of a Central Queensland gem miner, which used a comparatively small quantity of water, and in which, also, there was no loss of stones. He was having one of these washing plants made, and expected that it would prove very efficacious. This was the second of these machines, the first—that made by the inventor with the only articles that were available—being a comparatively crude though effective arrangement.

BARATTA SILVER-LEAD DEPOSITS.—Mr. L. Keith Ward, the South Australian Government Geologist, has submitted his report on the Baratta silver-lead field to the Minister of Mines in that State. The discovery leading to the rejuvenation of the district was made quite close to some of the old workings in the west part of the area formerly held under mineral leases. Slugs of almost pure galena were found partly embedded in the soil for a distance of many chains along the course of a well-defined vein. One of these slugs, forwarded to the Department of Mines, was found to contain 82% lead and 37 oz. of silver per ton. Three mineral claims, Nos. 11,256, 11,294, and 11,299, have been pegged out by the discoverers, and the work of opening up the lode has begun. The general trend of the lode is N. 68 E. (magnetic bearing), and small slugs of galena have been found for a distance of 100 ft. to the south-west of the south-west boundary of the central mineral claim (No. 11,256). On this boundary a shallow excavation shows semi-oxidized ore over a width of 6 ft. Some fragments of the picked ore, consisting of galena and cerussite, were assayed, and found to contain 77·2% lead, 46 oz. silver, and a trace of gold (not exceeding 1 dwt. per ton). The lode at this point appears to have a brecciated structure and contains veins of clean ore recoverable by hand-picking, as well as milling ore. The excavation, when seen by Mr. Ward, was only 3 ft. deep. Immediately to the north-east there is a shallow trench exposing veinlets of galena over a width of 21 ft. Another pit, 3½ chains from the boundary, is 5 ft. 6 in. deep, and exposes a brecciated formation over a width of 5 ft. The full width of the formation is not revealed in the opening, for ironstone is outcropping 10 ft. farther to the north-west, and traces of galena have been found in the formation for 10 ft. on the south-east side of the pit. The course of the lode can be traced practically continuously, by the presence of slugs of galena and traces of vein matter in place to the spot, 13 chains from the south-west boundary, where the galena was first discovered on the claim. At this place, where two tons of galena were gathered on the surface, a trench 6 ft. deep has been made along the course of the lode.

The principal vein is composed of clean galena up to 12 in. wide, and is exposed for a length of 27 ft. It has a very steep dip toward the south-east. On the foot-wall side there are at one point subsidiary veins over a width of about 3 ft., the formation being one from which first-class ore can be obtained by hand-picking. Fragments of the high-grade ore from this place were assayed, and found to contain 47·2% lead, 28½ oz. silver, and a trace of gold (not exceeding 1 dwt. per ton). Beyond this trench toward the north-east are two other small excavations from which galena has been recovered. The total length over which the formation has been traced is about 16 chains. From the several workings along the course of this lode a parcel of ore was dispatched to the smelters at Port Pirie. The net weight of this parcel was 6·44 tons, and the ore was found to contain 65·3% lead, 32·1 oz. silver per ton, and no zinc. Traces of vein matter of the same general type have been found in the south part of mineral claim No. 11,256, but the veins have not yet been opened up.

To the south-east of the three claims to which reference has been made above are two mineral claims held by virtue of Miners' Rights Nos. 7,241 and 7,240, on which some new discoveries have been made. At a point 3 chains to the south-south-east of the south corner of mineral claim No. 11,256 is a trench 6 ft. 6 in. deep along the course of a vein of clean galena 6 in. wide. The strike of the vein is N. 65 E., and the dip is to the S.S.E. at 73°. This lode has not yet been continuously followed to the south-west, but silicious vein matter of the normal type outcrops at intervals for nine chains, and is probably part of the same lode. The lode has been traced for about 5½ chains to the north-east, and at that point it disappears beneath a cover of soil. A trench along the lode, where last seen, shows a vein from 2 to 3 in. in width carrying clean galena. Still further to the north-east silicious veinstuff, with a little galena, is visible, but the connection between this lode matter and the south-westerly occurrence is not yet proved. Similar veinstuff, showing traces of galena, has been discovered in the adjoining claim to the north-east, Miners' Right No. 7,240, but little work has yet been carried out there. An old trench has been extended, and semi-oxidized ore containing pyromorphite has been found.

To the east of Eukaby Hill, on the steep eastern slope of a low hill, an open-cut is being carried into the hill-side in mineral claim No. 11,295. This opening was started on a vein said to have been from 4 in. to 6 in. wide, where it was formerly exposed many years ago. The width at the point reached on the occasion of Mr. Ward's visit was 15 in. The ore consists mainly of galena. There is a subsidiary vein dipping at a flat angle to the north-west, and this vein will probably join the other at a depth of a few feet. The galena carries vughs partly filled with crystals of cerussite. A parcel of about 5 tons of first-class ore from this place has been hand-dressed ready for dispatch to the smelters. A sample composed of fragments of the picked galena was found to contain 64·1% lead, 27½ oz. silver, and a trace of gold (not exceeding 1 dwt. per ton). The lode does not outcrop on the hill immediately above the workings, but other vein matter of similar general type and carrying galena has been recently discovered at two places between the workings mentioned and Eukaby Hill. Immediately to the north of Eukaby Hill, within the boundaries of mineral claim No. 11,291, a little new work has been done in tracing the course of a lode opened up 30 years ago; and a little high-grade galena has been obtained by hand-dressing the material formerly raised and stacked on the surface. One of the old excavations shows a formation about 30 ft. in total width, carrying several narrow seams of galena and cerussite. To the south of this excavation, and distant from it about 200 ft., a fresh discovery of lead carbonate has been made in a vein 6 in. wide, but the lode has not yet been followed downward nor along its course. This claim occupies the site of several of the workings dating from the period of former activity on the field. A little recent prospecting has been done to the west and north-west of Eukaby Hill, but so far without very promising results. To the west and south-west of the principal fresh discovery on mineral claim No. 11,256 prospecting operations are in progress. Veins containing the typical minerals found in the district have been located, but the amount of galena in them was insignificant in all excavations that had been made when the field was visited by Mr. Ward.

The newly-found lode in mineral claim No. 11,256 is certainly an important discovery that is worthy of systematic and vigorous development. While the data are not yet available for the discussion of ore reserves and probable productivity, the continuity of the lode over a considerable length, and its width at several points, are such that the owners should sink and drive on the lode at more than one place. Cross-cuts, to test the width and grade of the formation, should be made at short intervals. Only when this work has been performed will it be possible to regard the property as a mine the merits of which are to be judged from the ore exposed. This object should be kept in view in all the exploratory work below the surface. The future of the other newly-discovered lode is still less capable of prediction. Only the very earliest stage of prospecting has been reached, and in many cases the veins hitherto exposed at the surface are narrow and contain a small proportion of galena. It is important to discriminate between the vein and the ore-shoot. All or some of the minerals present in the type that is developed on the field may be present in any particular vein. Thus some veins consist almost wholly of quartz with traces of siderite altered in part to limonite. Others contain galena in addition, and these should be carefully followed at the surface with the object of discovering the places where the proportion of galena is highest, before deeper work is undertaken.

ELECTROLYTIC ZINC.—An important fusion of interests as regards zinc production has just been announced. Under the arrangement the mines and assets of the Mount Read & Rosebery, Ltd., are to be taken over as from July 31 by the Electrolytic Zinc Co. of Australia Pty., Ltd., the considerations for the sale being: (1.) The issue to the Mount Read & Rosebery Mines of 350,000 ordinary shares of £1 each, fully paid, in the Electrolytic Zinc Co. (2.) The right to the Mount Read Co. to take up 150,000 cumulative participating preference shares of £1 each in the Electrolytic Zinc Co. at par. (3.) The right of the Mount Lyell Co. to appoint two directors to the board of Electrolytic Zinc Co. The authorized capital of the Electrolytic Zinc Co. as at present constituted is £1,000,000 in 1,000,000 shares of £1 each. The issued capital is £600,000, in 600,000 ordinary shares of £1 each, fully paid. These are held by the undermentioned companies as follows: Amalgamated Zinc (De Bavay's), 240,000 shares; Broken Hill South, 120,000; North Broken Hill, 120,000; Zinc Corporation, 120,000; total, 600,000 shares. The directors of Electrolytic Zinc purpose to forthwith increase the subscribed capital of that company by a further issue of ordinary shares, which will be offered to the shareholding companies pro rata to their holdings at this date. Legal steps will then be taken to increase the authorized capital to £2,500,000, divided as follows: 1,250,000 ordinary shares of £1; and 1,250,000 8% cumulative participating preference shares of £1 each, preferential as to capital and dividends, and ranking pari passu with the ordinary shares in any dividend distribution over 8% on ordinary shares. It is intended to issue as rights to the individual shareholders in the constituent companies 1,050,000 preference shares upon such terms as to payment, etc., as the general meeting decides. Of the 1,250,000 ordinary capital, 350,000 shares of £1 each, fully paid, will, as intimated above, be issued to the Mount Read & Rosebery. These shares will be deferred as to dividends until July 31, 1925, after which date they will rank with the other ordinary shares issued in any distribution of profits.

The ore reserves of the Mount Read & Rosebery groups of mines are estimated at over 1,000,000 tons, averaging: Zinc, 27·4%; lead, 7·3%; silver, 9·57 oz. per ton; and gold, 0·127 oz. per ton. The Electrolytic Zinc Co. has also taken over the option of purchasing, from the Government of Tasmania, the Zeehan Smelting Works, etc. Meetings of the Electrolytic Zinc Co. will be convened at an early date, after which the intended issue of preference shares will be made.

A circular issued by the directors of the Mount Read & Rosebery states that the issued capital is 256,503 shares, while the company is under obligation to issue 97,500 shares to the Tasmanian Copper Ltd., making a total of 354,093 shares. The Mount Read Co. owes the Mount Lyell Co. on account of advances for working capital a total, with interest to June 30, of approximately £180,000. An arrangement has been made for the discharge of this indebtedness by an allotment of 180,000 of the deferred ordinary shares in the Electrolytic Zinc Co. The circular adds: In consideration of the Mount Lyell Co. being released from further obligation under its agreement with the Mount Read Co., it will accept 30,000 deferred ordinary shares in Electrolytic Zinc, in full settlement of its rights as the holder of 100,000 shares in the Mount Read & Rosebery. On a proportional basis the Mount Lyell Co. would have been entitled to approximately 48,000 shares. Should it be decided to distribute the remaining 140,000 deferred ordinary shares in the Electrolytic Zinc Co., shareholders would receive approximately 55 of such shares for each 100 shares held by them, but the distribution will be slightly reduced by the number of shares required to meet the company's expenses after June 30, 1920. It has been further agreed that the Mount Lyell Co. shall have the right to apply for 90,000 out of the 150,000 participating cumulative preference shares in Electrolytic Zinc, which Mount Read & Rosebery is entitled to subscribe for at par. It is the intention of the board to give shareholders the opportunity of taking up the remaining 60,000 shares when the issue is made by the Electrolytic Zinc.

The directors lay emphasis on the fact that whereas the Electrolytic Zinc Co.'s plant at Risdon, Hobart, was originally designed to produce 10 tons of electrolytic zinc per day, it has been running since January, 1918, and is producing 15 tons daily of the highest grade zinc, assaying over 99·95%. The construction of the plant to produce 100 tons per day of electrolytic zinc, together with substantial tonnages of various by-products, is steadily proceeding. Two-thirds of the new cell room is completed. The whole of the electrical equipment for 30,000 h.p. is expected to arrive at Hobart before the end of the year. The most important factors influencing the Mount Read board to agree to the sale were the greatly increased capital required for plant and equipment above what was contemplated at the time the company was formed, the difficulty in raising such capital, and the greatly extended time required to bring the plant into operation. They consider the location of the Risdon works to be ideal. Elaborate statements have been issued by the Tasmanian Government in this connection, and the uncommercial nature of establishing a second zinc deposition plant on the island, with the consequent duplication of outlay and effort, is emphasized. The position of the State of Tasmania under the new arrangement is officially stated to be: (1.) The Lake Rolleston scheme, like the King River scheme, will be held in abeyance. (2.) It will be possible to concentrate all efforts upon the Great Lake scheme and work it up to its full capacity, at the same time carrying power to Launceston. (3.) All mining, transport, smelting, and concentrating will be done at Rosebery and Zeehan. (4.) The Electrolytic Zinc Co. will have its own zinc-producing mines within the State, and will not have to depend upon Broken Hill as its sole source for the supply of concentrates.

EXTENSION OF THE "BETTERMENT" PRACTICE.—The Electrolytic Zinc Company of Australasia, Ltd., has cordially adopted the general plan previously adopted by three or four other mining and metallurgical companies in Australia for securing the comfort and welfare of their employees, the tendency of which should be, and probably will be, to prevent strikes by removing many irritating conditions which made the workers an easy prey to the agitator. Of course the agitator will not take kindly to the movement, because, should it become at all widespread, he might have to turn to and work, a possibility hardly worth considering. In the Electrolytic Zinc Company's scheme a co-operative council is to be formed consisting of nine members elected by ballot by the men from their own number, and three members representing the employers. The hope is that by giving the men such large representation in managing the company's business a fuller appreciation of the complexity of business will steadily be diffused among the employees than they have ever had. An insurance scheme has already been established, over which five representatives of each party preside, and to which each employee contributes 6d. a week and the company an equal amount; this is expected to enable £2 a week to be paid to each man in case of sickness or accident, in addition to whatever may be due under the Workers' Compensation Act, together with from £25 to £40 in case of accidental death. About 60 houses have already been erected, which will gradually be increased to 180, and these are balloted for by the men; they contain from 4 to 6 rooms and are well appointed and fitted with electric light. The company has also begun the opening of stores for the supply of daily wants; at present they mainly supply clothing, but other necessaries will be included later on, and in the meantime arrangements have been made with the private storekeepers to supply the company's employees at reduced rates. The trading branch of the concern will be controlled by three representatives of the company and three of the men, and this same body will control the social and sporting clubs, the brass band, the orchestra, and picnic, tennis, rowing, and cricket clubs. Special trains are also provided to carry the men to and from their work, and even a magazine has been started. Those who know most about publishing a magazine are not among the most hopeful for its success, but no one wishes it any harm.

SET-BACKS TO THE MINING INDUSTRY.—Two distinct and heavy blows to the mining industry in Australia have lately been dealt by boomsters. Goodness knows, the industry was already sufficiently hard-pressed by increasing costs of production, without any addition to its difficulties by men whose only interest is a gamble and a wish to "get rich quick." The first blow came from the failure of so many of the companies which took up blocks on the Hampton Plains (W.A.) to make good. Thousands and even tens of thousands of pounds were paid for leases which proved absolutely valueless, or, at the very best, unprofitable to work. There is this consideration, however: the excitement created by the Hampton Plains boom resulted in ventures in districts round about, and there is great hope that some of these may turn out well. The second blow, though struck in Melbourne, has relation to the Badak tinfield in the Federated Malay States. The Badak Tin Syndicate's doings will have been reported in London by cable, so I need not give details and only need say that the incident has had a very bad influence on the interests of legitimate mining.

CAMBORNE.

KILLIFRETH.—While we have always expressed our firm belief in the mining possibilities of this sett, we are equally convinced that the company is over-capitalized. Recently a further issue of £50,000 has been authorized, although only one moiety of this is to be immediately subscribed, and this further capital is required for the purpose of acquiring the lease of, and working, the adjoining property, called Wheal Busy. Mr. J. Gilbert expresses the opinion "that the two properties will be very cheap at a capitalization of £175,000." At this stage, however, if £100,000 was lopped off the capital, the capitalization would be nearer the mark. Wheal Busy is just an abandoned water-logged mine with certain possibilities as an arsenic producer, the plant on it belonging to Lord Falmouth, while the Killifreth mine itself is at present only unwatered to a shallow depth and its present production does not meet costs. Mr. Josiah Paull reports hopefully on Wheal Busy as an arsenic producer, and indeed forecasts that it could be made the largest producer in the county. The price of arsenic is, however, the key to the problem, and though the demand is good at the present time, this demand will probably so stimulate production that it is more than likely that the price will have a considerable fall later on. Deposits of arsenical pyrites are not scarce even in this county, so that expansion of production can be brought about if the demand warrants it. We would rather the company had confined its attention to Killifreth, where the chances are excellent; the trouble hitherto has been that although the nominal capital of the company was so large, the cash available for equipment and development has been inadequate. The Wheal Busy mill, etc., has been purchased by the mineral owner, Lord Falmouth, and will be used by the company at a nominal rental, while an option to purchase has been granted at the price paid for it by Lord Falmouth.

TIN AND TUNGSTEN RESEARCH.—From the annual report of the Privy Council Committee for Scientific and Industrial Research, we gather that the results to date do not give much encouragement, and all experimental work on flotation has been suspended pending the result of the experiments at East Pool and at South Crofty. We have before expressed the opinion that the committee, in spending so much time and money on concentration experiments and investigation, were working on wrong lines, and certainly results to date justify that criticism. The research work on the separation of tin from its ores by volatilization as chloride, carried out by Sir Thomas Kirke Rose and Mr. J. H. Goodchild, has shown that, with the present price of fuel in Cornwall, the cost of working is prohibitive.

NATIONALIZATION OF TIN MINES.—The proposal on this subject, referred to in the last issue, which will shortly receive the consideration of the Joint Industrial Council, has been condemned in no half-hearted fashion by Mr. J. Terrett, the local representative of the Metalliferous Miners' Union. Mr. Hillman, the local representative of the Dockers' Union, who is responsible for the proposal, has entirely condemned the wicked capitalists, who now, may it be said, probably to their regret own the mines, and paints a rosy picture of the future if the mines were owned by the Government and managed by the miners' representatives. Now Mr. Terrett has the temerity to say to Mr. Hillman: "I have no doubt there is a useful, but nevertheless a limited, future for Cornish mining. But to tell the miner that much can be achieved is to fill his belly with the east wind." As Mr. Terrett properly says, nationalization can only be fairly recommended, either for the purpose of recovering for the nation the profits of a highly successful industry, or for a beneficial purpose which private enterprise has failed to achieve. The Cornish metal-mining industry can, unfortunately, show no record of recent years sufficiently attractive to make the Government want to nationalize the industry, and it is folly to waste the time of the Industrial Council in discussing matters which have no chance, at present, of even being considered.

PERSONAL.

DR. T. LEWIS BAILEY has been appointed Chief Inspector under the Alkali Act, in succession to W. S. Curphy.

C. P. C. BERESFORD, general manager of Prestea Block A, is expected in London.

SIR HORACE BYATT has been appointed Governor of Tanganyika Territory, lately German East Africa.

ARTHUR J. CADDICK is here from Rio Tinto.

WILLIAM CLARK, of Lionel Robinson, Clark & Co., has left London on a short visit to Australia.

H. H. CLAUDET has returned to Ottawa after a lengthy visit to Miami.

H. J. DALY has left London on his return to West Australia.

F. DIXEY is on his way back to Sierra Leone.

W. J. DORAN has been appointed metallurgist for the North Mount Farrell Mining Company, Tasmania.

W. H. EPLETT is expected from Trengganu.

J. B. FERN is going to Spain.

J. A. L. GALLARD has resigned his position as associate editor of THE MINING MAGAZINE in order to take up an appointment on the financial staff of the *Daily Mail*.

DR. J. A. L. HENDERSON has left for Canada.

T. C. L. HOWARD, of Anaconda, passed through London this month on his way to the Congo State, to take up work for the Union Minière.

H. F. HUESTON has returned to Nigeria.

A. E. KITSON expects to leave shortly on his return to West Africa.

NEWTON B. KNOX is back from Spain to resume his position as consulting engineer to the Phœnician Mines, Ltd. His office is at Hornby House, 75B, Queen Victoria Street, London, E.C.4.

A. LEAVER has gone to Asia Minor for Borax Consolidated, Ltd.

ERNEST LEVY is joining the firm of Alexander Hill & Stewart.

M. C. H. LITTLE has gone to the Trentino, Italy.

E. LAWSON LOMAX is now in practice as a consulting petroleum technologist at Monument Chambers, King William Street, London, E.C.4.

W. J. LORING has retired from the firm of Bewick, Moreing & Co.

E. C. MARRIAGE has returned to Pioche, Nevada on the conclusion of a visit to England.

E. T. MCCARTHY has gone to China by way of the United States.

HANS MEYER is here from Johannesburg.

LOUIS D. MILLS, of the Merrill Company, passed through London on his way from San Francisco to Johannesburg last month.

WILLIAM MOTHERWELL is now at Trail, British Columbia.

C. H. MUNRO passed through London early this month on his way from the Federated Malay States to New York and San Francisco.

H. G. NEWTON has received an appointment with the Anglo-Persian Oil Co., and has left for Persia.

C. W. PURINGTON has left Japan for Northern Sakhalin in order to examine the coalfields.

R. ALLISON PURVIS, lately with the Spassky and Russo-Asiatic companies, has arrived in England after being held as a prisoner by the Bolsheviks in Krasnoyarsk and Irkutsk.

W. S. ROBINSON, managing director of Broken Hill Associated Smelters, has left on his return to Melbourne, travelling by way of America.

W. R. RUMBOLD has returned from Portugal.

W. RUSSELL, of the Dorr Co., has left for America.

C. T. SWEET has joined the staff of the Burma Corporation and has left for Burma.

F. W. THOMAS, of Williams, Harvey & Co., has left for New York.

H. A. TITCOMB is making his home at Palo Alto, California.

J. B. TYRRELL is visiting Newfoundland.

A. E. WELLS has been appointed head of the new division of the United States Bureau of Mining devoted to non-ferrous metallurgy.

SIR LINDSAY WOOD, for many years connected with the management of coal mines in Durham, died on September 21, aged 86. He was president of the North of England Institute of Mining and Mechanical Engineers from 1875 to 1878, and during his term of office did much propaganda work in favour of the introduction of coal-cutting machinery.

ALFRED E. FLETCHER, well known in years gone by as Government Inspector under the Alkali Act, died on September 17 at the age of 93. At first he was intended for the civil engineering profession and his first work was as a railway surveyor. Afterward he studied mathematics and chemistry at University College, London, where he won a gold medal in 1851. He was elected a Fellow of the Chemical Society in 1852. For some years he was among those endeavouring to develop the aniline dye industry. In 1863 he was appointed as assistant to Dr. Angus Smith, the first Chief Inspector under the Alkali Works Regulation Act of that year, the Act which gave powers for restraining the poisonous fumes till then discharged from chemical, metallurgical, and other works. He devised an aspirator for the rapid extraction and analysis of chimney gases, and an accurate anemometer for measuring the rates of flow in flues and chimneys; both these remained for many years in routine use. The principle of this anemometer was later applied successfully in his instrument for measuring the rate of a ship's movement. The device was reintroduced during the war, for registering the velocity of aeroplanes. In 1884 he succeeded Dr. Angus Smith as Chief Inspector, and he retired in 1893. He brought the smoke nuisance before the British Association meeting in 1870, and he worked continuously for the next 30 years towards its abatement.

TRADE PARAGRAPHS

HYATT, LTD., makers of the Hyatt Roller Bearings, are moving their offices from Devonshire Street to Thurloe Place, South Kensington.

MAVOR & COULSON, LTD., of 47, Broad Street, Mile End, Glasgow, send us their new catalogue of switch-gear for electric installations.

BRUCE PEEBLES & CO., LTD., of Edinburgh, send us a copy of their new pamphlet dealing with Peebles Self-Contained Polyphase Induction Motors.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO., of Pittsburg, Pennsylvania, send us particulars of their new electric arc furnace regulator.

BULLIVANT & CO., LTD., of 72, Mark Lane, London, E.C.3. and Millwall, send us their catalogue of wire ropes and apparatus used in rope haulage. They also send us an album of illustrated descriptions of many installations of aerial ropeways, at mines and elsewhere.

THE CHICAGO PNEUMATIC TOOL CO., of 6, East 44th Street, New York, send us a new catalogue describing their Chicago Pneumatic Slogger Rock-Drill. This machine is of the reciprocating type, and solid steels are used. It is intended particularly for deep-hole quarry work and heavy excavation.

W. H. DORMAN & CO., LTD., of Stafford, send us an elaborate pamphlet describing the wave-transmission system as applied to rock-drills, rivetters, and other reciprocating tools. This system was described in the Magazine for June last, and we hope to publish an illustrated description in an early issue.

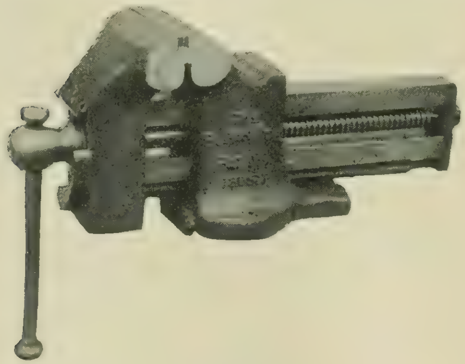
THE SULLLIVAN MACHINERY CO., of Chicago, and Salisbury House, London, E.C.2, send us the following publications: Bulletin 70K describing their Plug Drills, class DH3; bulletin 70J describing the Sullivan Rotators DP33, DP32, and DR37; and a pamphlet describing their system of core-drilling by contract.

THE DE LAVAL STEAM TURBINE CO., of 150, Southampton Row, London, W.C., representatives of AKTIEBOLAGET DE LAVALS ANGTURBIN, Stockholm, send us a number of catalogues, relating severally to steam-turbine feed-pumps, single-stage steam turbines, electrically-driven centrifugal pumps for mines, Zeta centrifugal pumps, and the Alfa-Laval oil clarifiers.

THE GENERAL ELECTRIC CO., LTD., of 67, Queen Victoria Street, London, E.C.4, send us their Bulletin No. 14 which deals with switchboards used in electric plants. They also send us a pamphlet describing the electric monorail hoists, winches, capstans, etc., which are made at the Witton-Kramer Electric Tool & Hoist Works, near Birmingham.

CENTRIFUGAL SEPARATORS, LTD., of 8 Iddesleigh House, Caxton Street, Westminster, write to say that the note in the last issue of the Magazine relating to the Gee centrifugal filter contained an error as to the control of the business. We are asked to state that though Centrifugal Separators, Ltd., have recently become associated with Vickers, Ltd., who manufacture the separators at their Barrow works, the business management remains in the hands of the company.

THE SUPER-VICE ENGINEERING CO., LTD., of Hoddesdon, Hertfordshire, have placed on the market a new vice, which they call the "Super-Vice," which, it is claimed, is designed and constructed on scientific and useful lines. The metal has been efficiently distributed. It has been cut down over the sloping jaws where it is unnecessary, and piled up under the jaws and in the travel of the back jaw-box, which are the weakest points. The finish is tool-room finish and its construction is 80% steel. The jaws extend one-third their width either side of the guides. This feature allows vertical or bent work to be gripped vertically. The five-inch size has a grip on vertical or bent work of 1¾ in. The jaws are high and sloping to allow acute angles to be filed on the smallest work. The slope and



THE SUPER-VICE.

lack of sharp corners prevent damaged knuckles. The patent lies in the fact that the quick release action has a whole nut divided vertically down its centre. When in a normal position this nut is locked solid and slip is impossible. The guides are steel and unbreakable. The efficient distribution of metal allows the cutting down of unnecessary metal which makes for a lighter tool. Weight is an item when shipping. The price is low. The vice sells at the price of an ordinary cast-iron vice.

THE TRAYLOR ENGINEERING & MANUFACTURING CO., of Allentown, Pennsylvania, send us a pamphlet describing their Superpump. This is a vertical, single-acting, outside-packed plunger pump. The following advantages are claimed: (1) It is the only pump which will successfully handle gritty or acid water; (2) Leakage is noticed as soon as it occurs and packing can be adjusted without stopping the machine; (3) Lubrication of any part can be accomplished during operation; (4) The pump is single-acting, so that all the working thrust is always in one direction, minimizing wear and vibration; (5) All strains are taken on finished bolts, eliminating loose joints and consequent packing; (6) The machine is highly sectionalized, which cuts down repair bills. As every part is easily accessible, only the single, inexpensive part directly affected need be removed. Also, by this construction, pumps of large size may be taken to and erected in locations which would otherwise be inaccessible. The pump is built in triplex and quintuplex, of every size and pressure which may be demanded, and for every conceivable service.

THE DENVER ROCK-DRILL MANUFACTURING CO., of Denver, Colorado, send us particulars of a new type of light mining and quarrying drill which, it is claimed, marks a substantial advance in the progress of air-drill manufacture. This new type of drill is built in three models, known respectively as Models NA-90, NRW-93, and NRD-95; the first-named being a "dry" auger drill, especially designed for work in coal, iron, and other soft formations; the second, a combination "wet" and "dry" rock-drill efficiently serviceable in all kinds of rock and under all conditions, either above or below ground; and the last-named, a "dry" rock-drill particularly adapted to work in wet shafts or where out-of-door conditions prevail. All three drills are extremely light, so that they can be easily carried about, and each is operated by one man. While most Waugh drills are of the valveless type, the "Nineties" are equipped with an entirely new type of spool valve, having a positive action. The rotation mechanism is of strong design in which stresses in both teeth and pawls are reduced to a minimum. Lubrication is effected by pulsations of air which gradually feed the oil from a reservoir at the side of the cylinder into all parts of the machine.

THE FRANCOIS CEMENTATION CO., LTD., of 18, South Parade, Bradford, send us the following information relating to the rehabilitation of the Lens coal mines. Contrary to general expectations, coal from the Lens area is already being won, the first truck loads having left on September 8. Owing to the systematic and thorough work of destruction carried out by the German Army in their retreat of 1918, it had not been anticipated that any coal could be drawn, at the earliest, before 1921. Practically the whole of the shafts in this district are sunk through heavily-watered chalk, by means of various tubbing systems, which the Germans destroyed by dynamite at depths down to 120 yards from the surface, thereby causing the complete flooding of the area. This water has, in most cases, risen to within a few yards of the surface. In many districts, numerous shafts give access to the same workings, thus greatly adding to the difficulties of the work of unwatering the coalfield. Surface arrangements had not only been subjected to the normal devastation of the fighting area, but all machinery and buildings were demolished before reoccupation by the Allied armies, so that when the work of reconstruction began a completely new start had to be made. Thus, the recommencement of drawing coal is an extremely hopeful sign of the determined efforts to open up the district, and it is expected to exercise a very great influence on the general financial situation in France as the output increases. It is anticipated that, very shortly, this output will be considerably augmented from pits 9 and 11, where cementation work has been completed to the exclusion of the inflowing water, and from other pits where this work is nearing completion. The completed work of cementation at the above-mentioned pits has been carried out by the Francois Cementation Co., Ltd., which was formed last December with a working capital of £25,000 for the purpose of exploiting the processes and inventions of Mr. Albert Francois, of Doncaster. In this case, all the work had to be carried out from the surface. Suitably placed boreholes were drilled and cement injected under pressure to seal off the water which was flowing into the shafts, the accumulated water being then readily pumped out. There is no doubt that the speedy recovery of the mines is, to a very large extent, being accelerated by the application of the methods used in the Francois process, which has been so successful in dealing with difficult water problems both in Great Britain, the Continent, and in the gold mines and hydraulic works in South Africa. The cementation at Lens has been remarkably rapid, especially in view of the difficulties of transport and housing and labour shortage. Much labour still remains to be done in the Lens area, both in excluding "new" water and in removing water which has accumulated in extensive workings, but the fact that coal has actually been won is extremely significant to the French consumer, who has been hampered in every way in the work of restoration of normal industrial conditions by the acute shortage of coal.

METAL MARKETS

COPPER.—Price movements during the past month have been of a somewhat see-saw character. For a time quite a strong tone prevailed under the resumption of heavy buying of standard warrants on Continental account. These purchases commenced during August, and were commented upon in our last review. It had not been expected that they would be persisted in for so long a time, but apparently the Continental sulphate manufacturers have been starved for raw material, and it had become necessary to replenish supplies. In all probability, not far from 15,000 tons of rough copper have been acquired for shipment, representing about 60,000 tons of sulphate. It may be thought the Italian vineyards cannot absorb the whole of this quantity, but if not, a market can no doubt be found in Italy, Greece, and the Islands, for any surplus. The force of the buying of standard copper naturally drove up prices, and it appeared for a time as if a more normal ratio were to be established between the quotations for rough and refined metal, but as soon as the demand for standard fell off prices slipped away again, so that in the end the old disparity has practically been re-established. The stocks of copper here will certainly be drawn upon heavily during the next month or so, and the effect of this may be seen in quotations, though it is strange how the market accommodates itself to varying conditions. Hence the withdrawal of metal from store here on a large scale may be counteracted by imports from other directions. The position of the markets as regards refined metal remains somewhat curious. The further fall in sterling exchange as between this country and America has naturally exerted a hardening tendency upon the prices of American electrolytic here, though the big group of producers across the Atlantic are getting fidgety and anxious to sell. Whether Europe steps in to pick up the load from their shoulders is quite an open question, particularly in view of the fact that exchange considerations entail an enormously increased cost to all European consumers of American commodities. It is too little understood that the fall in sterling exchange between here and America adds well over £30 a ton to the price of American copper in the United Kingdom based on normal exchange. Under these circumstances it is impossible for Europe to consume anything like its pre-war takings of metal, and all the countries involved in the exchange debacle will perforce have to use up their scrap, etc., in preference to obtaining supplies of new material. Consumers all round have been doing very little indeed, their reticence being accentuated by the threatening labour outlook, and it remains to be seen what course will ultimately be followed. The smaller producers and second-hand holders in America have at times been trying to force sales, but the quantities which they had to dispose of were not formidable, although the offerings tended to bring about an easier tone in the market; as this metal was picked up there, the position drifted more into the hands of the big producers, whose attitude meantime remains undisturbed. The strike at the Rio Tinto Co.'s mines seems even yet not to have been settled, production there being at a standstill, and under the most favourable circumstances it will take some time before operations can be resumed on the usual scale. Troubles appear to have broken out also in Central Africa, originally on the railways, but there have been no recent advices from this direction. An item of interest from Japan is that the chief producers there have been feeling the financial strain through which the country has been passing, and some kind of arrangement has been come to whereby the selling of their copper will be practically pooled, the arrangement applying not only to the stocks of metal on hand, but also to future output, which is reckoned to be on a basis of about 4,000 tons a month. The financing of the entire operation is attributed to the Bank of Japan, and it is believed that the deal has been organized with the approval of the chief producing group in America.

Average prices of cash standard copper: September 1920, £96. 13s. 4d.; August 1920, £94. 0s. 1d.; September 1919, £100. 17s. 4d.; August 1919, £97. 11s. 4d.

TIN.—There have been comparatively minor fluctuations in the tin market, the day-to-day movements being only of a moderate character; but following upon an improvement, a downward tendency developed, due mainly to financial considerations. The fact of the matter is that Chinese speculators in the East had been playing a bold hand in tin and rubber, but, the rubber speculations having gone wrong owing to the collapse in the price, they were forced to throw their tin overboard. The metal was absorbed with remarkable ease, and the fact that it has been cleared out of the way is a point in favour of the market. Another factor operating somewhat adversely for the bulls was the general labour conditions here, which naturally tended to reduce all operations to the narrowest possible basis. Apart from these temporary features tin appears to stand in a sound position. The world's consumption has been sufficiently good, even under the existing disturbed conditions, to absorb the accumulations held in the early part of the year, and any development in respect of general trade can, it is believed, be only for the better. At the same time it must be remembered that the Continent is by degrees getting back to work again, and in pre-war times both the Central Powers and Russia were more or less important consumers. It is no doubt looking too far ahead to anticipate any important developments in respect of Russia, but Germany is undoubtedly settling down to work again, and if reasonable consumption is to be provided for in this direction, it may become a question as to how the tin is to be supplied without forcing prices higher. Production in the East is only moderate, and the quantities coming forward could easily be increased without causing any disturbances. The Dutch authorities are selling tin regularly, but the quantities are of no special importance, and everything available appears to be wanted. The great bulk of the accumulations in Hong Kong have been liquidated, chiefly to the United States, while an increasing portion of the Bolivian ores is being smelted in North America. Altogether, there does not appear to be any reason to view the distant future with misgiving, particularly as the market in London is largely under the control of powerful interests who made their influence clearly apparent when they broke the price a few

DAILY LONDON METAL PRICES: OFFICIAL CLOSING
Copper, Lead, Zinc, and Tin per Long

	Copper				
	Standard Cash	Standard (3 mos.)	Electrolytic	Wire-Bars	Best Selected
Sept.	£ s. d. £ s. d	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
13	97 15 0 to 98 0 0	98 0 0 to 98 5 0	112 0 0 to 118 0 0	117 0 0 to 118 0 0	106 0 0 to 107 0 0
14	99 15 0 to 100 0 0	99 15 0 to 100 0 0	112 0 0 to 118 0 0	117 0 0 to 118 0 0	107 0 0 to 108 0 0
15	100 0 0 to 100 5 0	99 10 0 to 99 15 0	112 0 0 to 118 0 0	117 0 0 to 118 0 0	107 0 0 to 108 0 0
16	99 10 0 to 99 15 0	99 5 0 to 99 10 0	112 0 0 to 118 0 0	117 0 0 to 118 0 0	107 0 0 to 108 0 0
17	99 0 0 to 99 5 0	98 17 6 to 99 0 0	112 0 0 to 118 0 0	117 0 0 to 118 0 0	107 0 0 to 108 0 0
20	98 0 0 to 98 10 0	98 0 0 to 98 10 0	112 0 0 to 118 0 0	117 0 0 to 118 0 0	107 0 0 to 108 0 0
21	97 0 0 to 97 5 0	97 0 0 to 97 5 0	112 0 0 to 118 0 0	117 0 0 to 118 0 0	107 0 0 to 108 0 0
22	97 0 0 to 97 5 0	97 10 0 to 97 15 0	112 0 0 to 118 0 0	117 0 0 to 118 0 0	107 0 0 to 108 0 0
23	96 5 0 to 96 10 0	97 5 0 to 97 10 0	112 0 0 to 118 0 0	117 0 0 to 118 0 0	107 0 0 to 108 0 0
24	95 15 0 to 96 0 0	97 5 0 to 97 10 0	112 0 0 to 118 0 0	117 0 0 to 118 0 0	106 0 0 to 107 0 0
27	95 5 0 to 95 10 0	96 10 0 to 96 15 0	113 0 0 to 117 0 0	116 0 0 to 117 0 0	106 0 0 to 107 0 0
28	93 10 0 to 93 15 0	94 17 6 to 95 0 0	113 0 0 to 116 0 0	115 0 0 to 116 0 0	105 0 0 to 106 0 0
29	94 0 0 to 94 5 0	95 0 0 to 95 5 0	113 0 0 to 116 0 0	115 0 0 to 116 0 0	105 0 0 to 106 0 0
30	94 5 0 to 94 10 0	95 5 0 to 95 10 0	113 0 0 to 116 0 0	115 0 0 to 116 0 0	105 0 0 to 106 0 0
Oct.					
1	94 5 0 to 94 10 0	95 10 0 to 95 15 0	111 0 0 to 114 0 0	113 0 0 to 114 0 0	105 0 0 to 106 0 0
4	96 5 0 to 96 10 0	96 10 0 to 97 0 0	111 0 0 to 114 0 0	113 10 0 to 114 0 0	105 0 0 to 106 0 0
5	96 7 6 to 96 12 6	96 7 6 to 96 12 6	111 0 0 to 114 0 0	113 10 0 to 114 0 0	105 0 0 to 106 0 0
6	97 10 0 to 97 15 0	97 0 0 to 97 5 0	112 0 0 to 115 0 0	114 0 0 to 115 0 0	105 0 0 to 106 0 0
7	98 10 0 to 98 15 0	98 0 0 to 98 5 0	112 0 0 to 115 0 0	114 0 0 to 115 0 0	105 0 0 to 106 0 0
8	98 0 0 to 98 5 0	97 0 0 to 97 5 0	110 0 0 to 115 0 0	114 0 0 to 115 0 0	104 0 0 to 105 0 0

months ago. The excessive premium demanded here for Straits tin has fallen away, and with it the premium on Dutch tin. There is some talk of forming a market in Holland, the basis of dealings of which will be Banka and Billiton tin, but further information is awaited on this point. Whether London will become a competitor in Holland is another matter. Possibly the two markets may assist each other, possibly Holland may draw business away from London. Nobody can be too certain which will happen if the new market comes into existence.

Average prices of cash standard tin: September 1920, £270. 7s. 3d.; August 1920, £274. 5s. 10d.; September 1919, £343. 19s. 1d.; August 1919, £310. 16s. 8d.

LEAD.—A fair amount of activity has been seen in the lead market with some further buying for shipment to America, but as this demand dried up again, values assumed an easier tendency, the weaker tone being accentuated by heavy arrivals from Spain. In view of all the talk about acute scarcity in consequence of the cessation of production in Australia, it is remarkable that so much lead should have come in from other quarters to fill the gaps. It was understood that the Spanish output had been practically sold to France, which country during the early months of the year was drawing large supplies from that direction, but it is evident that French consumers and dealers over-estimated their capacity for absorption. Not only is Spanish lead, which was expected to find a home in France, being shipped direct from there, but French holders have also been re-selling and shipping lead to this country There have been several arrivals of lead from Germany, sales of this being facilitated by the adverse movements in exchange. A curious development in the lead market in America is that the price in New York has dropped below the level of St. Louis. Obviously the price in New York should be higher than than that of the inland centre, seeing that freight and other charges have to be added, but the reversal in the situation arises from imports from Europe at the Atlantic seaboard, which metal has been rather pressed for sale, and has knocked down values. Probably the position in this respect will adjust itself later, and meantime in order no doubt to facilitate matters, the leading producers in America have made repeated cuts in their price. The Australian situation appears to have cleared up considerably, the strike having ended, although production at the smelter has not yet been resumed. This, however, is only a matter of time. Buying for consumption has throughout the month been on a miserably poor scale, buyers being of one mind that prices are still much too high.

Average prices of lead: September 1920, £35. 7s. 6d.; August 1920, £36. 8s. 10d.; September 1919, £25. 12s. 6d.; August 1919, £25. 1s. 6d.

SPELTER.—During a good portion of the month of September prices of spelter had a decidedly retrograde movement, the main factors at work being various. For one thing it was confidently proclaimed that Germany had big surplus stocks which would have to be marketed regardless of price, and efforts were made accordingly by bringing down quotations on the London market to force out sellers. A certain quantity of metal was dislodged, but sellers then became wary, and, resisting the decline, have had the satisfaction of seeing prices advance steadily in London during the last week or two. In all probability the fall was overdone. Belgium has been selling fairly regularly, and Norway has stocks to dispose of; but American producers maintain their stiff attitude, declaring that it is impossible for them to produce at current prices, and asserting vehemently that the greatly reduced production in the United States is bound to have its effect upon the market sooner or later. The London market has undoubtedly been the world's cheapest centre for a long time, and it really seems questionable whether apart from Germany any country can produce spelter profitably on the basis of our quotations. Even the Belgian plants are pretty unanimous in saying that production is unremunerative, but for all this their output has shown a regular increase, practically month by month, although it is not yet equal to 50% of the prewar total.

Average prices of spelter: September 1920, £40. 5s. 6d.; August 1920, £41. 19s. 6d.; September 1919, £41. 8s. 4d.; August 1919, £39. 16s. 9d.

ZINC DUST.—There is a good demand for high-grade Australian zinc dust, and the price has remained steady at £85 per ton.

ANTIMONY.—Demand is poor, but the quotation of

PRICES ON THE LONDON METAL EXCHANGE.
Tons; Silver per Standard Ounce; Gold per Fine Ounce.

Lead: Soft Foreign	Lead: English	Zinc (Spelter)	Standard Tin: Cash	Standard Tin: 3 mos.	Silver: Cash	Silver: Forward	Gold	
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.			s. d.	Sept.
35 5 0 to 34 15 0	37 0 0	39 5 0 to 40 10 0	272 15 0 to 273 0 0	279 0 0 to 279 5 0	$59\frac{3}{8}$	59	—	13
35 0 0 to 34 15 0	37 0 0	39 2 6 to 40 12 6	274 5 0 to 274 10 0	279 10 0 to 279 15 0	$60\frac{1}{4}$	$58\frac{7}{8}$	119 0	14
34 15 0 to 34 10 0	37 0 0	39 2 6 to 40 7 6	273 10 0 to 274 0 0	279 5 0 to 279 10 0	$60\frac{3}{4}$	$60\frac{3}{8}$	118 9	15
35 0 0 to 35 0 0	37 0 0	39 2 6 to 40 10 0	274 15 0 to 275 0 0	279 10 0 to 279 15 0	$60\frac{1}{2}$	$60\frac{1}{8}$	118 0	16
35 15 0 to 35 0 0	37 10 0	39 12 6 to 40 17 6	277 0 0 to 277 5 0	281 10 0 to 281 15 0	60	$59\frac{5}{8}$	117 6	17
35 10 0 to 35 10 0	38 0 0	40 0 0 to 41 5 0	275 0 0 to 275 10 0	279 10 0 to 280 0 0	$59\frac{1}{8}$	$59\frac{1}{4}$	117 6	20
35 7 6 to 35 7 6	37 10 0	40 7 6 to 41 12 6	272 15 0 to 273 0 0	278 0 0 to 278 5 0	$59\frac{7}{8}$	60	117 6	21
34 17 6 to 34 17 6	37 0 0	40 10 0 to 41 15 0	269 15 0 to 270 0 0	275 10 0 to 276 0 0	60	$60\frac{1}{8}$	117 6	22
34 17 6 to 35 0 0	37 0 0	41 0 0 to 42 5 0	268 15 0 to 269 0 0	273 15 0 to 274 0 0	$59\frac{7}{8}$	60	117 6	23
34 17 6 to 35 0 0	37 0 0	40 17 6 to 41 17 6	268 15 0 to 269 0 0	274 0 0 to 274 5 0	$59\frac{3}{8}$	$59\frac{1}{2}$	117 9	24
34 17 6 to 35 0 0	37 0 0	41 5 0 to 42 0 0	271 0 0 to 271 5 0	276 10 0 to 276 15 0	$59\frac{3}{8}$	$59\frac{1}{4}$	117 11	27
35 0 0 to 34 15 0	37 0 0	41 2 6 to 42 2 6	270 15 0 to 271 0 0	276 15 0 to 277 0 0	$59\frac{3}{8}$	$59\frac{1}{8}$	117 11	28
34 17 6 to 34 15 0	37 0 0	40 15 0 to 41 15 0	268 10 0 to 268 15 0	274 10 0 to 274 15 0	$59\frac{1}{8}$	$58\frac{7}{8}$	117 9	29
34 10 0 to 34 7 6	37 0 0	40 15 0 to 41 10 0	268 0 0 to 268 10 0	274 0 0 to 274 10 0	$59\frac{3}{8}$	$59\frac{1}{8}$	118 4	30
								Oct.
34 7 6 to 34 5 0	36 5 0	40 5 0 to 41 5 0	271 10 0 to 271 15 0	276 10 0 to 276 15 0	59	$58\frac{3}{4}$	118 4	1
34 12 6 to 34 15 0	37 0 0	40 15 0 to 41 15 0	271 15 0 to 272 0 0	277 10 0 to 277 15 0	$58\frac{1}{4}$	$57\frac{5}{8}$	118 0	4
34 12 6 to 34 12 6	36 5 0	40 15 0 to 41 15 0	270 0 0 to 270 10 0	275 0 0 to 275 10 0	$57\frac{3}{8}$	$57\frac{1}{8}$	117 10	5
34 10 0 to 34 7 6	36 0 0	40 12 6 to 41 15 0	269 10 0 to 270 0 0	274 10 0 to 275 0 0	$56\frac{7}{8}$	$56\frac{3}{4}$	117 1	6
34 7 6 to 34 2 6	35 10 0	40 17 6 to 41 17 6	267 0 0 to 267 10 0	272 10 0 to 273 0 0	$56\frac{1}{8}$	$55\frac{5}{8}$	117 3	7
34 7 6 to 34 5 0	35 10 0	40 2 6 to 41 7 6	266 0 0 to 266 10 0	270 5 0 to 270 15 0	$56\frac{1}{8}$	56	117 0	8

English regulus is unchanged at £52 per ton for ordinary quality and £55 for special brands. There are sellers of foreign material in warehouse at £45, but there is no doubt that lower bids would be accepted.

ARSENIC.—This market presents a very dull appearance, but the price of Cornish white is somewhat firmer at about £77 per ton delivered London or Liverpool.

BISMUTH.—Quite a fair business has been passing in this market, and the price has remained steady at 12s. 6d. per lb.

CADMIUM.—This market has been dull, and the quotation is lower at about 6s. to 6s. 3d. per lb.

ALUMINIUM.—Prices have kept steady at £165 for home and £185 for export business.

NICKEL.—For both home and export the price is still £230.

COBALT METAL.—After its recent rise, the price has kept firm at 30s. per lb.

COBALT OXIDE.—Black oxide is quoted at about 20s. per lb.

PLATINUM.—The quotation is nominal at about £31 per oz.

PALLADIUM.—This is also a nominal market at £30 per oz.

QUICKSILVER.—The market has had an irregular tone, being swayed alternately by outside offers from the Continent and by the firm position of first hands here. The quotation to-day is about £18 to £18. 10s. There is some talk of a combination of interests being arranged between the leading producers in Italy, Idria, and Spain, and negotiations to that end are understood to be proceeding.

SELENIUM.—10s. 6d. to 13s. per lb.

TELLURIUM.—The quotation is nominal at 90s. to 95s. per lb.

SULPHATE OF COPPER.—Prices in this market have shown a rather easier tendency, and the quotation both for home and export business is £43.

MANGANESE ORES.—The quiet tone in this market has continued, and Caucasian and Indian grades are now about 3s. 9d. c.i.f. per unit.

TUNGSTEN ORES.—Germany has been a steady buyer of tungsten ores, but the market on the whole has shown very little alteration, although there are occasionally small fluctuations suggesting that an easier tone is developing. Germany has been paying about 25s. 6d. c.i.f. Hamburg for good grade wolfram concentrate, but it is doubtful whether so much would be paid to-day, German buyers in fact appearing to regard the position of the market as unstable.

SILVER.—An upward tendency was noticeable in this market at the beginning of the month, the price of spot bars opening at $57\frac{5}{8}$d. on September 1, and rising to $60\frac{3}{4}$d. (its highest level for the month) on September 15. During the latter half of September the quotation of spot bars fluctuated within very narrow limits and closed at $59\frac{3}{8}$d. on September 30.

GRAPHITE.—This market has kept extremely steady, and prices have shown no change during the month. Soft velvety flake, 85 to 90%, is quoted at £60 to £80 per ton, while Madagascar, 82 to 85%, is about £25 c.i.f.

MOLYBDENITE.—The price is nominal in the neighbourhood of 75s. to 80s. c.i.f. U.K.

CHROME ORES.—There is no appreciable change in the quotation, which is still about £8 to £8. 5s. c.i.f. U.K. for 50% ores.

IRON AND STEEL.—No alteration in Cleveland pig iron prices took place during the past month, so that No. 1 remains at 237s. 6d. and No. 3 G.M.B. at 225s. Both the home and foreign demand have been quiet, as the threatened strike of coal miners made both buyers and sellers cautious. Foundry grades of Cleveland iron are still exceptionally scarce, and no export business is being entertained. Makers, however, have been able to release a few small supplies of the lower grades for shipment. Quotations for hematite also remain unchanged, East Coast Mixed Numbers standing at 260s. for the home trade and 265s. for export. Supplies at one time were somewhat increased, but toward the latter end of the month became scarce again, merchants' stocks being diminished. In the finished iron and steel trade very little new business has been put through, partly owing to the fears of a coal strike, and partly owing to the fact that prices in this country are above the buying capacity of most of the overseas markets. Material has been offered by Continental works at prices considerably below those quoted here, but even these makers are in need of orders.

STATISTICS.

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand	Elsewhere	Total	Par Value
	Oz.	Oz.	Oz.	£
June, 1919	682,603	19,776	702,379	2,983,515
July	705,523	19,974	725,497	3,081,713
August	686,717	19,952	706,669	3,001,739
September	680,359	18,199	698,558	2,967,287
October	705,313	18,409	723,722	3,074,174
November	657,845	20,125	677,920	2,879,834
December	631,833	18,358	650,191	2,761,836
Year 1919	8,111,271	218,820	8,330,091	35,383,974
January 1920	653,295	17,208	670,503	*
February	607,918	17,412	625,330	*
March	689,645	17,391	707,036	*
April	667,926	19,053	686,979	*
May	681,551	17,490	699,041	*
June	699,199	16,758	715,957	*
July	718,521	17,578	736,099	*
August	683,604	18,479	702,083	*

* Not given in the official returns.

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold mines	Coal mines	Diamond mines	Total
June 30, 1919	172,505	12,544	5,831	190,880
July 31	173,613	12,453	5,736	191,802
August 31	170,844	12,450	5,655	188,949
September 30	169,120	12,392	5,294	186,806
October 31	167,499	12,691	4,492	184,682
November 30	164,671	12,565	4,337	181,573
December 31	166,155	12,750	4,271	183,176
January 31, 1920	176,390	12,766	4,796	193,952
February 29	185,185	12,708	5,217	203,110
March 31	188,564	12,788	5,232	206,584
April 30	189,446	12,951	5,057	207,454
May 31	184,722	12,897	4,793	202,412
June 30	179,827	13,036	4,596	197,459
July 31	174,187	13,005	4,521	191,713
August 31	169,263	13,535	4,244	187,042

COST AND PROFIT ON THE RAND.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 65% of the working profit. Figures for yield and profit for 1919 based on par value of gold; subsequently gold premium included.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
July, 1919	2,134,668	27 10	21 9	6 0	611,118
August	2,036,128	28 5	22 11	5 5	551,203
September	2,019,109	28 6	22 10	5 7	560,979
October	2,108,698	28 3	22 6	5 10	612,841
November	1,933,526	28 8	23 5	5 5	521,472
December	1,845,088	28 8	25 6	3 10	354,098
Year 1919	24,043,638	28 7	22 11	5 6	6,605,509
January, 1920	2,038,092	34 4	24 2	10 2	1,036,859
February	1,869,180	35 1	28 3*	6 10*	644,571*
March	2,188,104	31 8	25 2	6 6	716,610
April	2,065,446	31 5	26 3	5 2	533,940
May	2,117,725	31 9	25 11	5 10	618,147
June	2,146,890	31 10	25 2	6 8	692,510
July	2,194,050	33 6	24 6	9 0	985,058

* Results affected by the back-pay disbursed in accordance with new wages agreement.

PRODUCTION OF GOLD IN RHODESIA AND WEST AFRICA.

	Rhodesia. 1919	Rhodesia. 1920	West Africa. 1919	West Africa. 1920
	£	oz.	£	
January	211,917	43,428	104,063	
February	220,885	44,237	112,616	
March	225,808	45,779	112,543	
April	213,160	47,000	109,570	
May	218,057	46,266	100,827	No official returns published.
June	214,215	45,054	106,612	
July	214,919	46,[illegible]	102,467	
August	207,339	48,740	103,112	
September	223,719	—	100,401	
October	204,184	—	91,352	
November	186,462	—	98,322	
December	158,835	—	95,806	
Total	2,499,498	366,712	1,240,691	

TRANSVAAL GOLD OUTPUTS.

	July. Treated	July. Yield	August. Treated	August. Yield
	Tons	Oz.	Tons	Oz.
Aurora West	10,750	£14,916	10,400	£15,623
Brakpan	52,800	21,792	52,250	21,477
City Deep	90,600	36,753	90,500	36,805
Cons. Langlaagte	47,200	£68,313	44,000	£69,022
Cons. Main Reef	52,500	18,433	51,000	17,359
Crown Mines	200,000	61,789	185,000	56,962
Durban Roodepoort Deep	26,000	8,348	23,800	7,626
East Rand P.M.	140,000	36,121	129,000	37,530
Ferreira Deep	34,300	11,505	33,800	11,438
Geduld	45,000	15,626	45,000	15,797
Geldenhuis Deep	51,400	13,921	48,500	13,584
Glynn's Lydenburg	3,868	£7,834	3,800	£8,947
Goch	14,700	£17,656	13,600	£17,104
Government G.M. Areas	139,000	£287,265	128,000	£278,456
Kleinfontein	49,160	14,812	46,460	12,957
Knight Central	28,200	7,965	26,500	7,610
Knights Deep	98,300	16,873	89,400	16,437
Langlaagte Estate	43,500	£71,465	42,500	£71,966
Luipaard's Vlei	19,430	£24,587	19,000	£27,043
Meyer & Charlton	14,560	£45,678	14,300	£50,790
Modderfontein	89,000	45,215	85,000	44,309
Modderfontein B	56,000	28,226	55,000	28,653
Modderfontein Deep	44,400	23,370	42,300	21,858
Modderfontein East	24,000	7,618	20,700	7,323
New Unified	11,700	£15,574	11,100	£15,853
Nourse	45,300	14,147	44,100	13,630
Primrose	21,500	£22,194	20,500	£22,851
Princess Estate	—	765	—	1,133
Randfontein Central	157,000	£194,674	125,000	£186,337
Robinson	41,400	8,935	41,100	8,625
Robinson Deep	58,600	18,824	55,700	16,770
Roodepoort United	25,100	£27,805	24,000	£28,097
Rose Deep	60,400	15,682	58,000	14,948
Simmer & Jack	61,600	£77,064	56,600	12,712
Springs	42,000	18,613	41,000	19,017
Sub Nigel	10,500	34,032	11,000	6,502
Transvaal G.M. Estates	17,980	£30,172	17,550	£33,914
Van Ryn	36,950	£46,423	32,750	£47,603
Van Ryn Deep	53,800	£142,687	47,850	£150,175
Village Deep	52,700	15,839	53,300	16,109
Village Main Reef	15,800	4,951	15,000	4,049
West Rand Consolidated	34,000	£48,509	34,000	£52,905
Witwatersrand (Knights)	38,400	£55,610	35,350	£57,084
Witwatersrand Deep	33,000	8 938	34,400	9,118
Wolhuter	34,000	9,043	32,200	9,112

WEST AFRICAN GOLD OUTPUTS.

	July. Treated	July. Value	August. Treated	August. Value
	Tons	Oz.	Tons	Oz.
Abbontiakoon	8,736	£14,884	7,361	£13,010
Abosso	3,780	1,557	4,581	1,741
Akoko	202	171	—	—
Ashanti Goldfields	3,332	4,465	3,728	4,530
Obbuassi	916	526	—	—
Prestea Block A	8,872	£14,743	10,028	£16,018
Taquah	3,220	1,781	3 250	1,852

RHODESIAN GOLD OUTPUTS.

	July. Treated	July. Value	August. Treated	August. Value
	Tons	£	Tons	£
Falcon	16,003	38,184*	15,608	34,212*
Gaika	3,786	5,923	3,682	5,678
Globe & Phœnix	5,862	8,076†	6,547	7,985†
London & Rhodesian	2,535	2,862	—	—
Lonely Reef	4,920	4,866†	5,270	5,213†
Planet-Arcturus	3,641	5,879	4,580	7,283
Rezende	5,550	2,475†	5,500	2,482†
Rhodesia, Ltd.	792	293	503	167
Rhodesia, G.M. & I.	613	217	575	293†
Shamva	51,900	42,813	52,400	47,372
Transvaal & Rhodesian	1,550	5,617	—	—

* Gold, Silver and Copper; † Ounces Gold.

West Australian Gold Statistics.—Par Values.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
June, 1919	1,050	73,546	74,596	316,862
July	680	68,028	68,708	292,852
August	835	58,117	58,952	250,410
September	†	†	†	†
October	586	64,987	65,573	278,535
November	1,171	64,823	65,994	280,323
December	831	27,334	28,165	162,575
January, 1920	836	25,670	26,506	112,590
February	1,928	49,453	51,381	218,251
March	—	54,020	54,020	229,461
April	835	56,256	57,091	242,506
May	227	50,976	51,203	217,495
June	502	56,679	57,181	242,638
July	—	48,341	48,341	205,340
August	167	54,258	54,425	231,185
September	141	54,940	55,081	233,963

† Figures not received.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1919	1920	1919	1920	1919	1920
	£	Oz.	£	Oz.	£	£
January	36,238	7,105	37,100	4,724	18,000	28,000
February	46,955	8,677	43,330	7,200	24,000	15,000
March	40,267	24,126	48,000	6,973	16,000	22,000
April	63,818	6,368	61,200	8,368	24,000	12,000
May	37,456	13,263	38,200	8,432	16,000	13,800
June	41,465	15,707	44,600	13,725	17,000	8,700
July	37,395	—	42,060	9,596	22,000	17,410
August	51,564	—	49,700	9,900	20,000	—
September	76,340	—	37,120	—	13,000	—
October	39,018	—	36,100	—	28,000	—
November	40,735	—	32,720	—	51,000	—
December	63,311	—	44,500	—	31,000	—
Total	575,260	75,246	514,630	68,918	280,000	116,910

Australasian Gold Outputs.

	July.		August.	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Associated	6,084	9,366	5,590	7,311
Blackwater	1,672	3,428	1,493	3,574
Bullfinch	6,140	2,150‡	6,150	1,092‡
Golden Horseshoe	11,952	4,889‡	11,472	4,892‡
Great Boulder Prop.	9,498	27,975	9,305	27,884
Ivanhoe	13,950	4,880‡	13,915	5,494‡
Kalgurli	4,239	5,426	3,313	4,959
Lake View & Star	9,926	11,069	9,237	10,795
Menzies Consolidated	1,600	2,593	1,540	2,936
Mount Boppy	—	—	6,501	4,600
Oroya Links	1,263	11,910†	1,557	12,437†
Progress	880	1,279	550	576
Sons of Gwalia	11,120	15,919	10,468	15,092
South Kalgurli	8,185	2,689‡	7,498	2,519‡
Waihi	13,443	3,909‡	13,686	4,309‡
Waihi Grand Junction	5,800	1,879‡	6,100	1,998‡
Yuanmi	1,944	4,734	2,005	4,358

† Including royalties; ‡ Oz.

Miscellaneous Gold Outputs.—Par Values.

	July.		August.	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
El Oro (Mexico)	33,500	246,000†	34,000	233,000†
Esperanza (Mexico)	22,629	3,154§	18,957	35,260§†
Frontino & Bolivia (C'lbia)	2,550	9,487	2,380	7,853
Mexico El Oro (Mexico)	11,850	222,030†	11,800	198,770†
Oriental Cons. (Korea)	—	66,000†	—	75,500†
Ouro Preto (Brazil)	6,900	2,472‖	6,400	2,186‖
PlymouthCons.(Calif'rnia)	7,800	9,596	6,850	7,822
St. John del Rey (Brazil)	—	36,000	—	34,000
Santa Gertrudis (Mexico)	25,120	17,580‡	28,630	19,740‡

§ Loss. † Dollars. ‡ Profit, gold and silver. ‖ Oz.

Production of Gold in India.

	1916	1917	1918	1919	1920
	oz.	oz.	oz.	oz.	oz.
January	45,214	44,718	41,420	38,184	39,073
February	43,121	42,566	40,787	36,834	38,872
March	43,702	44,617	41,719	38,317	38,760
April	44,797	43,726	41,504	38,248	37,307
May	45,055	42,901	40,889	38,608	38,191
June	44,842	42,924	41,264	38,359	37,864
July	45,146	42,273	40,229	38,549	37,129
August	45,361	42,591	40,496	37,850	37,375
September	45,255	43,207	40,088	36,813	35,497
October	45,061	43,041	39,472	37,138	—
November	45,247	42,915	36,984	39,628	—
December	48,276	44,883	40,149	42,643	—
Total	541,077	520,362	485,236	461,171	340,068

Indian Gold Outputs.

	August.		September.	
	Tons Treated	Fine Ounces	Tons Treated	Fine Ounces
Balaghat	3,300	2,363	3,200	2,468
Champion Reef	12,503	6,404	11,623	5,016
Mysore	20,120	13,193	18,485	12,851
North Anantapur	800	962	800	952
Nundydroog	8,736	6,004	8,450	5,753
Ooregum	12,900	8,449	12,700	8,457

Base Metal Outputs.

		July.	Aug.
Arizona Copper	Short tons copper	1,500	1,500
British Broken Hill	Tons lead conc.	—	—
	Tons zinc conc.	—	—
	Tons carbonate ore	—	—
Broken Hill Block 10	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Burma Corp.	Tons refined lead	1,525	1,975
	Oz. refined silver	190,070	243,340
Fremantle Trading	Long tons lead	—	401
Hampden Cloncurry	Tons copper	581	573
North Broken Hill	Tons lead	—	—
	Oz. silver	—	—
Poderosa	Tons copper ore	410	430
Rhodesian Broken Hill	Tons lead	1,283	1,446
Tanganyika	Long tons copper	2,558	—*
Tolima	Tons silver-lead conc.	47	60
Zinc Corp.	Tons zinc conc.	—	—
	Tons lead conc.	—	—

* Production suspended by strike.

Imports of Ores, Metals, etc., into United Kingdom.

		August.	September.
Iron Ore	Tons	606,696	487,211
Manganese Ore	Tons	50,574	50,934
Copper and Iron Pyrites	Tons	67,751	61,966
Copper Ore, Matte, and Precipitate	Tons	859	1,360
Copper Metal	Tons	11,038	12,135
Tin Concentrate	Tons	2,037	2,454
Tin Metal	Tons	1,950	1,888
Lead, Pig and Sheet	Tons	14,767	16,872
Zinc (Spelter)	Tons	5,170	10,688
Quicksilver	Lb.	17,735	55,120
Zinc Oxide	Tons	469	298
White Lead	Cwt.	28,413	23,543
Barytes	Cwt.	71,197	56,469
Phosphate	Tons	19,194	36,210
Sulphur	Tons	22	2,190
Borax	Cwt.	177	790
Other Boron Compounds	Tons	1,138	1,167
Nitrate of Soda	Cwt.	183,516	249,911
Nitrate of Potash	Cwt.	14,308	4,129
Petroleum:			
Crude	Gallons	2234	—
Lamp Oils	Gallons	8,025,227	16,737,647
Motor Spirit	Gallons	16,800,791	21,403,584
Lubricating Oils	Gallons	5,539,977	11,559,291
Gas Oil	Gallons	5,208,452	3,012,797
Fuel Oil	Gallons	44,689,070	31,247,535
Total Petroleum	Gallons	80,272,808	83,961,228

Outputs of Tin Mining Companies.
In Tons of Concentrate.

	June Tons	July Tons	August Tons
Nigeria:			
Associated Nigerian	20	20	–
Benue	–	–	–
Bisichi	6	15	9
Bongwelli	1	1	1
Dua	1½	3	2½
Ex-Lands	30	35	32
Filani	5	6	–
Forum River	7	8	11
Gold Coast Consolidated	3¾	4½	4
Gurum River	14	14	14
Jantar	6	6	14
Jos	9¼	13¼	18
Kaduna	6¼	9¼	9½
Kaduna Prospectors	6¾	7	3¾
Kano	5¼	3¾	3
Kuru	10	14	12
Kwall	6	–	–
Lower Bisichi	6	8¾	8½
Lucky Chance	1	1¾	1½
Minna	2½	3¼	3
Mongu	34	30	30
Naraguta	35	46	45
Naraguta Extended	20	25	26
Nigerian Consolidated	9	17	23
Ninghi	4½	4	4½
N.N. Bauchi	38	37½	47¼
Offin River	15½	9	–
Rayfield	35	35	35
Ropp	72	78	57
Rukuba	2	4¾	–
South Bukeru	6	7	6
Sybu	2½	2¼	2⅞
Tin Fields	10	11½	11½
Yarde Kerri	4½	4	2½
Federated Malay States:			
Chenderiang	78½*	–	–
Gopeng	60	60	60
Idris Hydraulic	22½	19⅓	26¾
Ipoh	11	11	15
Kamunting	88*	–	–
Kinta	41¾	30	30
Lahat	41⅔	44⅔	44⅔
Malayan Tin	65½	60	65½
Pahang	215½	217½	216½
Rambutan	18	15	15
Sungei Besi	31	31	30
Tekka	30	30	30
Tekka-Taiping	36	36	33
Tronoh	27	27	28
Cornwall:			
East Pool	80	95½	86
Geevor	36	38½	–
Grenville	35¾	21	–
South Crofty	52½	51¼	54
Other Countries:			
Aramayo Francke (Bolivia)	140	133	–
Berenguela (Bolivia)	28	33	26
Briseis (Tasmania)	20	20	26
Deebook (Siam)	14	–	8½
Mawchi (Burma)	82	84	–
Porco (Bolivia)	19	10	18
Renong (Siam)	28½	43½	45½
Rooiberg Minerals (Transvaal)	50½	45	45
Siamese Tin (Siam)	71½	73½	85¼
Tongkah Harbour (Siam)	94	75	–
Zaaiplaats (Transvaal)	[illegible]	28	30

* Three months.

Nigerian Tin Production.
In long tons of concentrate of unspecified content.

Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1915	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons	Tons
January	417	531	667	678	613	547
February	358	528	646	668	623	477
March	418	547	655	707	606	505
April	444	486	555	584	546	467
May	357	536	509	525	483	383
June	373	510	473	492	484	435
July	455	506	479	545	481	484
August	438	498	551	571	616	447
September	442	535	538	520	561	—
October	511	584	578	491	625	—
November	467	679	621	472	536	—
December	533	654	655	518	511	—
Total	5,213	6,594	6,927	6,771	6,685	3,745

Production of Tin in Federated Malay States.
Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons
January	4,316	3,558	3,149	3,765	4,265
February	3,372	2,755	3,191	2,673	3,014
March	3,696	3,286	2,608	2,819	2,770
April	3,177	3,251	3,308	2,855	2,606
May	3,729	3,413	3,332	3,404	2,741
June	3,435	3,489	2,950	2,873	2,940
July	3,517	3,253	3,373	3,756	2,824
August	3,732	3,413	3,259	2,955	2,786
September	3,636	3,154	3,166	3,161	—
October	3,681	3,436	2,870	3,221	—
November	3,635	3,300	3,131	2,972	—
December	3,945	3,525	3,023	2,413	—
	43,871	39,833	37,370	36,867	23,946

Total Sales of Tin Concentrate at Redruth Ticketings

	Long tons	Value	Average
August 25, 1919	130½	£18,297	£140 4 3
September 8	115½	£16,588	£143 12 6
September 22	135½	£19,557	£144 6 9
October 8	72	£10,867	£150 18 7
October 20	32	£5,093	£159 3 2
November 3	34½	£5,235	£151 15 0
November 17	39	£6,161	£157 19 9
December 1	38	£5,905	£155 8 3
December 15	29	£5,133	£176 10 0
December 31	14¾	£2,884	£195 10 10
Total and Average, 1919	2,858	£366,569	£128 5 0
January 12, 1920	31	£6,243	£201 8 0
January 26	51¾	£10,574	£204 6 10
February 9	37½	£7,880	£210 2 8
February 23	53¾	£12,120	£225 10 0
March 8	18	£4,038	£224 7 7
March 22	44	£8,286	£188 6 8
April 6	44½	£8,367	£188 0 5
April 19	33⅓	£6,375	£190 6 0
May 3	61⅛	£11,641	£189 5 9
May 17	44	£6,151	£139 16 0
May 31	10	£1,578	£157 16 0
June 14	24¾	£3,278	£132 9 3
June 28	14½	£1,932	£133 4 10
July 12	43¾	£6,133	£140 4 0
July 26	10½	£1,643	£156 10 0
August 9	10⅓	£1,664	£158 10 0
August 23	27¼	£4,022	£147 12 0
September 6	19	£2,563	£134 18 6
September 20	10	£1,552	£155 5 0
October 4	9	£1,359	£151 0 7

On September 6, Tincroft sold 10½ tons at an average price of £150. 15s. per ton, and Penryn Minerals sold 8½ tons averaging £115. 13s. 4d.

On September 20, Tincroft sold 10 tons, averaging £155. 5s.

On October 4, the sales were: Tincroft, No. 1, 5 tons, averaging £150. 15s. per ton; and No. 1a, 4 tons, averaging £151. 7s. 6d. per ton.

STOCKS OF TIN

Reported by A. Strauss & Co. Long Tons.

	June 30.	July 31.
	Tons	Tons
Straits and Australian Spot	347	853
Ditto, Landing and in Transit	730	155
Other Standard, Spot and Landing	4,882	3,525
Straits, Afloat	900	1,250
Australian, Afloat	207	169
Banca, in Holland	413	1,160
Ditto, Afloat	800	1,323
Billiton, Spot	—	—
Billiton, Afloat	—	145
Straits, Spot in Holland and Hamburg	—	—
Ditto, Afloat to Continent	301	60
Total Afloat for United States	6,717	7,916
Stock in America	3,586	1,926
Total	18,883	18,482

SHIPMENTS, IMPORTS, SUPPLY, AND CONSUMPTION OF TIN.

Reported by A. Strauss & Co. Long tons.

	June	July
Shipments from:	Tons	Tons
Straits to U.K.	750	1,275
Straits to America	3,210	2,555
Straits to Continent	301	35
Straits to Other Places	289	152
Australia to U.K.	150	250
U.K. to America	1,217	1,244
Imports of Bolivian Tin into Europe	1,993	—
Supply:		
Straits	4,261	3,865
Australian	150	250
Billiton	—	145
Banca	914	1,470
Standard	1,498	1,614
Total	6,823	7,344
Consumption:		
U K. Deliveries	1,691	1,939
Dutch ,,	—	—
American ,,	6,500	5,530
Straits, Banca & Billiton, Continental Ports, etc.	550	276
Total	8,741	7,745

DIVIDENDS DECLARED BY MINING COMPANIES.

Date	Company	Par Value of Shares	Amount of Dividend
Sept. 28	Anaconda Copper	$50.	$1
Oct. 2	Aramayo Francke	£1.	2s. less tax
Oct. 11	Borax Consolidated	£5 Pref. Ord.	6% less tax
Oct. 6	Central Provinces Prospecting	£1.	8% less tax
Sept. 13	Chino Copper	$5.	37½ cents
Oct. 6	Cock's Pioneer	£1.	1s. less tax
Oct. 9	Crescens (Matabele)	10s.	10% less tax
Sept. 20	Ferreira Deep	£1.	2s. 6d.
Sept. 30	Gold Coast Amal.	£1.	6d. less tax
Oct. 6	Gold Fields Rhodesian	10s.	6d. less tax
Sept. 17	Gopeng Consolidated	£1.	9d. less tax
Oct. 4	Hollinger Consol.	$5.	1%
Sept. 21	Ivanhoe	£5.	1s. 6d. less tax
Sept. 20	Kerr Lake	$4.	12½ cents less tax
Sept. 17	Kramat Pulai	£1.	1s. less tax
Oct. 6	Lonely Reef	£1.	25% less tax
Sept. 13	Nevada Consolidated Copper	$5.	25 cents
Oct. 2	New Lafon	2s.	12½% less tax
Sept. 10	New Boksburg Gold Mines	£1.	2s.*
Sept. 27	New Jagersfontein	£1.	5s. less tax
Oct. 5	Ooregum	Pref. 10s.	1s. 9d. less tax
		Ord. 10s.	9d. less tax
Sept. 17	Pengkalen	Prf. Ord. £1.	3s. less tax
		Ord. £1.	1s less tax
Sept. 13	Ray Consolidated Copper	$10.	25 cents
Oct. 6	Renong Tin	£1.	7½% less tax
Sept. 15	Shamva Mines	£1.	1s. 6d. less tax
Sept. 21	Sons of Gwalia	£1.	1s. less tax
Sept. 16	Sungei Besi	£	1s. less tax
Oct. 8	Tekka	£1.	4½d. less tax
Sept. 24	Transvaal G.M. Estates	£1.	6d
Sept. 13	Utah Copper	$10.	$1·50

* Liquidation dividend.

PRICES OF CHEMICALS. October 8.

These quotations are not absolute; they vary according to quantities required and contracts running.

		£	s.	d.
Alum	per ton	20	0	0
Alumina, Sulphate of	,,	17	0	0
Ammonia, Anhydrous	per lb.		2	6
,, 0·880 solution	per ton	39	0	0
,, Carbonate	per lb.			7½
,, Chloride of, grey	per ton	60	0	0
,, ,, ,, pure	per cwt.	5	5	0
,, Nitrate of	per ton	60	0	0
,, Phosphate of	,,	120	0	0
,, Sulphate of	,,	24	10	0
Antimony Sulphide, Golden	per lb.		1	6
Arsenic, White	per ton	76	0	0
Barium Sulphate	,,	12	0	0
Bisulphate of Carbon	,,	60	0	0
Bleaching Powder, 35% Cl.	,,	26	0	0
Borax	,,	41	0	0
Copper, Sulphate of	,,	42	0	0
Cyanide of Sodium, 100%	per lb.		1	0
Hydrofluoric Acid	,,			7½
Iodine	,,		16	0
Iron, Sulphate of	per ton	4	0	0
Lead, Acetate of, white	,,	77	0	0
,, Nitrate of	,,	60	0	0
,, Oxide of, Litharge	,,	55	0	0
,, White	,,	63	0	0
Lime, Acetate, brown	,,	20	0	0
,, ,, grey 80%	,,	31	0	0
Magnesite, Calcined	,,	25	0	0
Magnesium, Chloride	,,	15	0	0
,, Sulphate	,,	14	0	0
Methylated Spirit 64° Industrial	per gal.		8	2
Phosphoric Acid	per lb.		1	9

		£	s.	d
Potassium Bichromate	per lb.		1	9
,, Carbonate 85%	per ton	105	0	0
,, Chlorate	per lb.		0	11½
,, Chloride 80%	per ton	40	0	0
,, Hydrate (Caustic) 90%	,,	118	0	0
,, Nitrate	,,	66	0	0
,, Permanganate	per lb.		3	9
,, Prussiate, Yellow	,,		1	10
,, Sulphate, 90%	per ton	45	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	52	0	0
,, Arsenate 45%	,,	60	0	0
,, Bicarbonate	,,	9	0	0
,, Bichromate	per lb.		1	3
,, Carbonate (Soda Ash)	per ton	16	0	0
,, ,, (Crystals)	,,	7	0	0
,, Chlorate	per lb.			5½
,, Hydrate, 76%	per ton	32	0	0
,, Hyposulphite	,,	31	0	0
,, Nitrate, 95%	,,	24	0	0
,, Phosphate	,,	44	0	0
,, Prussiate	per lb.		1	2
,, Silicate	per ton	11	0	0
,, Sulphate (Salt-cake)	,,	8	0	0
,, ,, (Glauber's Salts)	,,	9	0	0
,, Sulphide	,,	46	0	0
Sulphur, Roll	,,	18	5	0
,, Flowers	,,	18	5	0
Sulphuric Acid, Fuming, 65°	,,	24	0	0
,, ,, free from Arsenic, 144°	,,	6	5	0
Superphosphate of Lime, 18%	,,	5	0	0
Tartaric Acid	per lb.		3	0
Tin Crystals	,,		1	11
Zinc Chloride	per ton	30	0	0
Zinc Sulphate	,,	22	10	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	October 7 1919 £ s. d.	October 7 1920 £ s. d.
Rand:		
Brakpan	3 15 0	2 16 3
Central Mining (£8)	10 8 9	8 2 6
City & Suburban (£4)	10 9	7 6
City Deep	3 6 3	2 15 0
Consolidated Gold Fields	2 5 0	1 6 3
Consolidated Langlaagte	1 5 0	16 3
Consolidated Main Reef	13 3	14 3
Consolidated Mines Selection (10s.)	1 7 0	1 1 3
Crown Mines (10s.)	3 8 9	2 11 3
Daggafontein	1 4 9	10 0
Durban Roodepoort Deep	8 3	5 0
East Rand Proprietary	8 3	9 0
Ferreira Deep	13 3	11 6
Geduld	3 3 9	1 16 3
Geldenhuis Deep	11 6	8 3
Gov't Gold Mining Areas	5 0 0	4 5 0
Heriot	12 6	8 6
Johannesburg Consolidated	1 11 6	1 6 6
Jupiter	5 3	1 9
Kleinfontein	16 0	6 9
Knight Central	6 0	4 0
Knights Deep	10 6	6 0
Langlaagte Estate	19 6	16 0
Meyer & Charlton	4 7 6	4 10 0
Modderfontein (10s.)	30 0 0	3 16 3*
Modderfontein B (5s.)	9 2 6	1 13 9‡
Modder Deep (5s.)	2 8 9	2 3 9
Modder East	1 17 6	1 3 9
New State Areas	—	1 8 9
Nourse	16 6	10 3
Rand Mines (5s.)	3 12 6	2 15 0
Rand Selection Corporation	3 15 0	2 17 6
Randfontein Central	1 0 6	14 9
Robinson (£5)	10 0	7 6
Robinson Deep A (1s.)	1 2 6	13 9
Rose Deep	18 9	18 6
Simmer & Jack	6 3	3 9
Simmer Deep	2 9	3
Springs	2 17 6	2 0 0
Sub-Nigel	1 7 6	17 6
Union Corporation (12s. 6d.)	1 3 9	17 6
Van Ryn	1 1 3	16 3
Van Ryn Deep	4 12 6	3 17 6
Village Deep	17 0	10 6
Village Main Reef	12 6	5 0
West Springs	1 7 6	16 3
Witwatersrand (Knight's)	1 5 0	13 9
Witwatersrand Deep	11 0	9 0
Wolhuter	4 6	4 9
Other Transvaal Gold Mines:		
Glynn's Lydenburg	18 9	13 9
Transvaal Gold Mining Estates	17 6	10 0
Diamonds in South Africa:		
De Beers Deferred (£2 10s.)	25 17 6	17 0 0
Jagersfontein	7 2 6	4 5 0
Premier Deferred (2s. 6d.)	10 0 0	10 0 0
Rhodesia:		
Cam & Motor	5 6	12 0
Chartered British South Africa	1 3 0	15 9
Falcon	14 3	13 6
Gaika	17 0	16 0
Globe & Phœnix (5s.)	1 0 0	17 6
Lonely Reef	3 11 3	2 16 3
Rezende	5 5 0	2 15 0
Shamva	2 0 0	1 13 9
Willoughby's (10s.)	7 6	5 6
West Africa:		
Abbontiakoon (10s.)	4 9	3 0
Abosso	14 0	11 0
Ashanti (4s.)	1 3 6	17 0
Prestea Block A	6 6	2 0
Taquah	16 6	13 6
West Australia:		
Associated Gold Mines	3 6	3 3
Associated Northern Blocks	4 6	3 6
Bullfinch	2 6	3 3
Golden Horse-Shoe (£5)	1 10 0	16 3
Great Boulder Proprietary (2s.)	10 9	7 0
Great Fingall (10s).	1 9	1 9
Hampton Properties	—	10 0
Ivanhoe (£5)	2 0 0	1 5 0
Kalgurli	12 6	16 3
Lake View Investment (10s.)	1 5 3	15 9
Sons of Gwalia	6 6	7 0
South Kalgurli (10s.)	6 6	6 0

Gold, Silver, cont.	October 7 1919 £ s. d.	October 7 1920 £ s. d.
Others in Australasia:		
Blackwater, New Zealand	8 9	8 9
Consolidated G.F. of New Zealand	3 6	3 9
Mount Boppy, N.S.W. (10s.)	0 9	6 3
Progress, New Zealand	1 9	1 9
Talisman, New Zealand	8 9	6 6
Waihi, New Zealand	2 6 3	1 12 6
Waihi Grand Junction, New Z'lnd	13 0	10 0
America:		
Buena Tierra, Mexico	17 6	10 0
Camp Bird, Colorado	1 2 6	13 6
El Oro, Mexico	1 0 0	17 6
Esperanza, Mexico	17 0	2 5 0
Frontino & Bolivia, Colombia	8 9	8 9
Le Roi No. 2 (£5), British Columbia	11 3	5 0
Mexico Mines of El Oro, Mexico	8 7 6	7 7 6
Nechi (Pref. 10s.), Colombia	12 6	8 9
Oroville Dredging, Colombia	1 12 6	1 7 6
Plymouth Consolidated, California	1 7 0	1 0 0
St. John del Rey, Brazil	18 6	15 0
Santa Gertrudis, Mexico	1 15 6	1 1 6
Tomboy, Colorado	16 0	10 0
Russia:		
Lena Goldfields	1 7 6	1 0 0
Orsk Priority	—	10 0
India:		
Balaghat (10s.)	4 9	8 6
Champion Reef (2s. 6d.)	4 3	2 6
Mysore (10s.)	1 15 0	15 6
North Anantapur	5 0	4 6
Nundydroog (10s.)	14 0	7 6
Ooregum (10s.)	15 6	13 9
COPPER:		
Arizona Copper (5s.), Arizona	2 0 0	2 3 9
Cape Copper (£2), Cape and India	2 5 0	1 0 0
Esperanza, Spain	5 9	5 0
Hampden Cloncurry, Queensland	19 0	13 9
Mason & Barry, Portugal	2 3 9	1 10 0
Messina (5s.), Transvaal	5 0	5 6
Mount Elliott (£5), Queensland	4 0 0	1 5 0
Mount Lyell, Tasmania	1 4 6	1 2 0
Mount Morgan, Queensland	1 4 9	18 6
Mount Oxide, Queensland	9 0	3 9
Namaqua (£2), Cape Province	1 12 6	1 10 0
Rio Tinto (£5), Spain	53 10 0	29 10 0
Russo-Asiatic Consd., Russia	—	12 0
Sissert, Russia	1 1 3	11 3
Spassky, Russia	1 17 6	17 6
Tanganyika, Congo and Rhodesia	4 13 9	1 12 6
LEAD-ZINC:		
Broken Hill:		
Amalgamated Zinc	1 6 6	1 6 3
British Broken Hill	2 1 3	1 15 0
Broken Hill Proprietary (8s.)	2 6 0	2 10 0
Broken Hill Block 10 (£10)	1 3 9	1 1 3
Broken Hill North	2 12 6	2 6 3
Broken Hill South	2 5 0	2 6 3
Sulphide Corporation (15s.)	1 2 6	16 3
Zinc Corporation (10s.)	1 1 0	16 3
Asia:		
Burma Corporation (10 rupees)	11 6 3	12 6†
Russian Mining	17 6	10 0
Rhodesia:		
Rhodesia Broken Hill (5s.)	14 9	11 0
TIN:		
Aramayo Francke, Bolivia	4 0 0	3 2 6
Bisichi, Nigeria	13 6	10 0
Briseis, Tasmania	4 6	4 3
Dolcoath, Cornwall	9 0	3 0
East Pool (5s.) Cornwall	1 0 0	8 9
Ex-Lands Nigeria (2s.), Nigeria	3 6	2 9
Geevor (10s.) Cornwall	1 2 6	10 0
Gopeng, Malay	2 1 3	1 17 6
Ipoh Dredging, Malay	1 0 6	15 0
Kamunting, Malaya	2 6 3	2 10 0
Kinta, Malaya	2 15 0	2 0 0
Malayan Tin Dredging, Malay	2 5 0	1 15 0
Mongu (10s.), Nigeria	1 2 6	17 6
Naraguta, Nigeria	16 3	11 3
N. N. Bauchi, Nigeria (10s.)	8 0	3 0
Pahang Consolidated (5s.), Malay.	15 6	10 6
Rayfield, Nigeria	15 3	8 0
Renong Dredging, Siam	2 12 6	2 3 9
Ropp (4s.), Nigeria	1 0 9	8 6
Siamese Tin, Siam	3 5 0	3 5 0
South Crofty (5s.), Cornwall	11 3	12 0
Tehidy Minerals, Cornwall	1 7 6	15 0
Tekka, Malay	4 5 0	1 2 6§
Tekka-Taiping Malay	6 2 6	1 1 3§
Tronoh, Malay	2 7 6	1 11 3

* £4 shares split into 8 of 10s. each. † 10-rupee shares of Indian Co. § New shares. ‡ £1 shares split into 4 of 5s. each.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

MINERALS IN MOROCCO.

The *Bulletin* of the Imperial Institute, published last month, contains two articles on the minerals of Morocco, one forming part of a résumé of Messrs. Mulock and Barker's report for the Department of Overseas Trade, and the other giving details of tests of minerals submitted for examination at the Imperial Institute. We extract herewith some of the information in these articles.

The mineral resources of the country exist mostly in the mountainous regions of the Atlas and the Riff, which are as yet neither fully explored nor brought under law and order. Small samples derived from the French zone have been examined at the Imperial Institute, and reports on the more interesting are given later in this abstract. They include good iron ores, suitable for the production of steel by the acid Bessemer process, galena, manganese ore, and a promising nickeliferous oxide of iron and arsenic. Petroleum is stated to exist at Petit Jean in the French zone. The Protectorate Government intends to exploit the extensive phosphate beds round El Boroudj, seventy-eight miles south of Casablanca, on its own account. These deposits, which, like those of Tunis, are of Eocene age, have been valued at £3,600,000,000. It is intended to construct a special mineral line from El Boroudj to Fedala, a port a few kilometres from Casablanca, which is to be fully equipped for the shipment of minerals.

The only minerals being worked as yet on any scale in Morocco are those of the Riff in the Spanish zone in the neighbourhood of Melilla, where there are three considerable iron mines and one working lead and zinc ore. The most important is that of the Cia. Española Minas del Riff, working large superficial masses of excellent specular hematite, averaging 63% of iron, by open-cut, at a present output of from 15,000 to 20,000 tons per month. The company intends building a mechanical loader with a capacity of 600 to 700 tons per hour at Melilla harbour, at an estimated outlay of £120,000. The company's concession exceeds 2,000 hectares, and in about two years they have extracted 400,000 to 500,000 tons, the Moors being supposed to have taken out 300,000 tons previously. The Setolazar Company, working the Navarrete mine, has an equally extensive concession, estimated to contain more than 4,000,000 tons of iron ore: in 1918 they shipped 61,000 tons, all to the United Kingdom, their present output being 300 tons daily. The Norte Africano Co. have a monthly output of 200 tons of lead ore from pockets near the surface, worked on inclined planes, averaging 82% lead, all shipped to Cartagena, in addition to calamine estimated to contain 40% zinc. Deposits of specular and dark hematite likely to prove valuable are known to occur in the unpacified zone west of Melilla, within 5 or 6 kilometres of the sea. From the neighbourhood of Tetuan, where as yet only a small area has been pacified, samples have been sent to the Imperial Institute, including brown hematite containing 80·7% of ferric oxide and 4·96% of manganous oxide, which might be used for spiegeleisen; some other hydrated iron oxides, containing rather more phosphorus than is admissible for Bessemer steel; and a high-grade galena. Coal, platinum, mercury, sapphires, and copper ores are also reported from this region, and it is suggested that a British engineer should be sent out to survey, with powers to buy claims outright.

The Imperial Institute reports as follows on the samples of minerals examined:

Samples of iron ore, Nos. 1–4, were stated to have been obtained from the neighbourhood of the Atlas Mountains.

No. 1 gave the following analysis: ferric oxide, Fe_2O_3, 83·23%; ferrous oxide, FeO, 1·28%; titanium dioxide, TiO_2, 0·30%; silica, SiO_2, 5·54%; copper, Cu, 0·45%; nickel, Ni, nil; sulphur, S, 0·08%; phos-

OUTLINE MAP OF MOROCCO.

phorus, P, 0·04%; loss on ignition, 5·17%. The metallic iron content was 59·2%. This material represents a good-quality iron ore which would be suitable for smelting, and for the production of steel by the acid Bessemer process, although the quantity of phosphorus is slightly above the maximum amount usually considered permissible in the United Kingdom for the latter purpose.

No. 2 consisted of iron oxides (hematite and limonite) together with a little quartz. On analysis the following results were obtained: ferric oxide, Fe_2O_3, 87·31%; ferrous oxide, FeO, 0·90%; titanium dioxide, TiO_2, 0·40%; silica, SiO_2, 5·70%; sulphur, S, trace; phosphorus, P, 0·014%; loss on ignition, 3·39%. The metallic iron content was 61·81%. This was a good-quality iron ore, suitable for the production of a good pig iron, and for the manufacture of steel by the acid Bessemer process.

No. 3 sample consisted of hematite, which on analysis gave the following results: ferric oxide, Fe_2O_3, 95·95%; ferrous oxide, FeO, 1·04%; titanium dioxide, TiO_2, 0·20%; silica, SiO_2, 1·60%; sulphur, S, 0·06%; phosphorus, P, 0·01%; loss on ignition, 0·69%. The metallic iron content was 68%. This was a high-grade iron ore suitable for the production of pig iron or for the manufacture of steel by the acid Bessemer process.

No. 4 sample consisted of hematite, with some quartz and a small amount of cupriferous matter. It was analysed with the following results: ferric oxide, Fe_2O_3, 77·11%; ferrous oxide, FeO, 0·81%; titanium dioxide, TiO_2, 0·32%; copper oxide, CuO, 0·20%; zinc oxide, ZnO, nil; nickel oxide, NiO, nil; antimony oxide, Sb_2O_3, nil; silica, SiO_2, 13·65%; sulphur, S, 0·062%; phosphorus, P, 0·013%; loss on ignition, 1·95%. The metallic iron content was 54·6%. The amount of silica present in this sample was somewhat high for an iron ore, but the material might be used locally for smelting.

No. 5 came from El Hawatt in Beni Said. It consisted of brown hydrated iron ore containing some quartzose impurity. It was analysed with the following results: ferric oxide, Fe_2O_3, 80·72%; ferrous oxide, FeO, nil; manganous oxide, MnO, 4·96%; titanium dioxide, TiO_2, nil; silica, SiO_2, 4·14%; sulphur, S, 0·03%; phosphorus, P, 0·022%; loss on ignition, 10·11%. The metallic iron content was 56·5%, and that of manganese 3·85%. This was a good-quality iron ore, suitable for the production of pig iron and for the manufacture of steel by the acid Bessemer process. The ore might also be used for the manufacture of spiegeleisen, but the product would contain rather less manganese than is usually required.

No. 6 came from D'har D'Shaib, between Anasel and Tsamrabitz, in Beni Said (Tetuan). This was a sample of manganiferous iron ore with thin veins of quartz. It was analysed with the following results: ferric oxide, Fe_2O_3, 73·22%; ferrous oxide, FeO, nil; manganous oxide, MnO, 4·99%; titanium dioxide, TiO_2, nil; alumina, Al_2O_3, 1·02%; lime, CaO, 1·32%; magnesia, MgO, 0·37%; silica, SiO_2, 10·14%; phosphorus, P, 0·03%; sulphur, S, 0·09%; loss on ignition, 8·92%. The metallic iron content was 51·25%. This was a fairly good-quality manganiferous iron ore, suitable for the production of pig iron or low-manganese spiegeleisen. The pig iron might possibly be used for the production of steel by the acid process, but it would contain a somewhat larger percentage of phosphorus than is usually allowed in iron intended for this purpose.

No. 7 came from Gebel Ewaharan, near the village of Ewaharan in Beni Said. The specimens were from the surface at about one kilometre from the sea-shore. This was a sample of ferruginous quartzose material, which on analysis gave the following results: ferric oxide, Fe_2O_3, 65·80%; manganese oxide, Mn_3O_4, 1·92%; gold, Au, trace; silver, Ag, 12·5 grains per ton. The metallic iron content was 46%. This material contains too much silica to permit of its exportation as an iron ore, but it might be used for smelting locally. The quantity of precious metals present is not sufficient to add to the value of the ore. Specimens from El Mah del Hauwat, near the village of Kerdidda in Beni Said (Tetuan) and about 1 kilometre distant from Gebel Ewaharan, and from El Ferrishah, near the village of Handanet Temncodet in Beni Said (Tetuan), were generally similar to sample No. 7.

No. 8 came from Emerzokan, near Tsamrabitz in Beni Said, very near the sea-shore. This was a compact manganiferous iron ore, with some quartz. On breaking the specimens for analysis a small crystal of autunite was seen, but careful search failed to reveal any further evidence of this material. The material was analysed with the following results: ferric oxide, Fe_2O_3, 70·28%; manganous oxide, MnO, 4·17%; titanium dioxide, TiO_2, trace; silica, SiO_2, 16·15%; phosphoric anhydride, P_2O_5, 0·02%; sulphuric anhydride, SO_3, 0·03%. The metallic iron content was 49·16%. This ore contained rather too much silica to permit of its being remuneratively exported to Europe. The pig iron or low-manganese spiegeleisen obtainable by smelting the ore would, however, be suitable for the production of steel by the acid process.

Two samples of nickel ores were tested at the Institute.

No. 1 came from the neighbourhood of the Atlas Mountains. This consisted of two small fragments, one green and nickeliferous, the other brown and ferruginous. An analysis was made on a representative portion of the entire sample and gave the following results: nickel oxide, NiO, 24·60%; copper oxide, CuO, nil; lead oxide, PbO, nil; zinc oxide, ZnO, nil; ferric oxide, Fe_2O_3, 25·31%; cobalt oxide, CoO, 1·12%; manganous oxide, MnO, 2·38%; arsenious oxide, As_2O_3, 19·74%. The nickel content was 19·34%, that of iron 17·72%, that of arsenic 14·95%. This material, if available in quantity, would be of value as a source of nickel.

No. 2 came from Seba Lowajit in Beni Bouzera, Ghomara, near the sea-shore. The specimens were stated to be from the surface of a hilly region in which no previous mining had been carried on. This sample consisted of pyrrhotite, accompanied by some biotite and pyroxene and small amounts of other minerals, including monazite. It was analysed with the following results: copper, 0·77%; iron, 38·90%; nickel, 3·63%; cobalt, 0·37%; silica, 15·88%; cerium earths, etc., trace; platinum metals, 7·8 grains per ton; gold, nil; silver, 3·88 grains per ton. Lead, zinc, and manganese were absent. This material compares favourably as regards the amount of nickel present with the nickeliferous pyrrhotites worked in the Sudbury district of Canada, but the percentage of copper is much lower, as also are the amounts of silver and platinum metals. If ore of the quality of the present sample is available in sufficient quantity, its working on a commercial scale would prove remunerative.

A sample of manganese ore was examined at the Institute. This came from the neighbourhood of the Atlas Mountains. The specimen consisted of black manganese oxide, which on analysis gave the following results: manganous oxide, MnO, 1·33%; manganese dioxide, MnO_2, 85·84%; ferric oxide, Fe_2O_3, 0·80%; lead, Pb, 0·89%; copper, Cu, trace; sulphur, S, 0·13%; phosphorus, P, 0·05%; silica, SiO_2, 0·69%. The metallic manganese content was 55·26%. The analysis indicates a fairly good-quality manganese ore, suitable for the manufacture of ferro-manganese, but containing rather less manganese dioxide than is usually considered desirable for material intended for use in dry batteries. The ore would be quite suitable for use in chemical manufactures.

A sample of lead ore was examined, coming from the neighbourhood of the Atlas Mountains. This consisted chiefly of galena. On analysis the following results were obtained: lead, 67·45%; copper, trace; iron, 1·02%; manganese, trace; silica, 1·25%; gold, nil; silver, 8 oz. 10 dwt. per ton. This was a good-quality lead ore, free from objectionable impurities.

A sample of copper ore came from the neighbourhood of the Atlas Mountains. This was a specimen of ferruginous and calcareous gossan with a little copper. It was analysed with the following results: zinc oxide, ZnO, trace; copper oxide, CuO, 1·93%; lead oxide, PbO, nil; ferric oxide, Fe_2O_3, 39·01%; gold, 6 dwt. 3 gr. per ton; silver, 1 oz. 2 dwt. 21 gr. per ton. This was equivalent to 1·54% of metallic copper and 27·30% of metallic iron. This material might possibly be worked profitably for copper and gold.

It will be seen from the above analyses that several of the mineral samples are of promising character. In the case of iron ores Nos. 1–4, nickel ore No. 1, and the manganese, lead, and copper ores, the samples examined were small, and consequently it will not be safe to assume that the results of the analyses represent the average composition of the deposits. The presence of monazite in the nickel ore from Seba Lowajit is of interest, and it was suggested that it might be worth while to examine any heavy sands found along the neighbouring sea-shore or river-beds in order to ascertain if this mineral occurs in workable quantities. The occurrence of a uranium mineral (autunite) in the iron ore from Emerzokan is of interest. It was recommended that a further examination of this locality should be made in order to ascertain whether autunite occurs in sufficient amount to be worth working.

In conclusion it should be added that the localities from which many of the specimens were obtained are not named closely, for obvious business reasons. In particular, "in the neighbourhood of the Atlas" is decidedly vague.

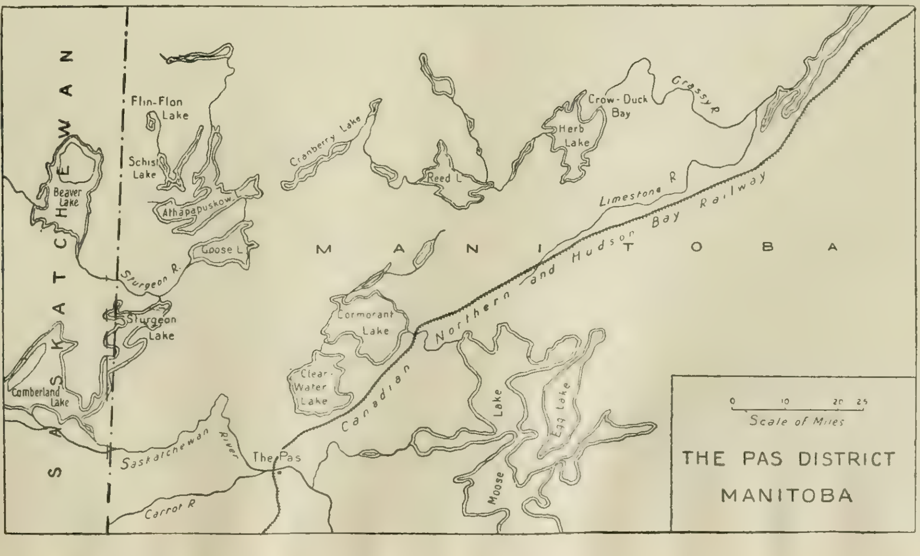
THE PAS MINING DISTRICT, MANITOBA.

On several occasions we have referred to the copper-gold deposits north of The Pas, Northern Manitoba, on Flin-Flon and Athapapuskow lakes, particularly in the issue of November, 1916. In *Economic Geology* for August, E. L. Bruce gives an account of the geology of the district and of the ore-bodies. This we quote herewith.

Geology.—The rocks associated with the ores are all of Pre-Cambrian age, but it may be mentioned that Palæozoic dolomites cover the older rocks south of lake Athapapuskow, and that Glacial and post-Glacial deposits form a discontinuous cover of varying thickness over all of the consolidated rocks. The Pre-Cambrian succession is as follows: (1) Granite; (2) granite-gneiss; (3) hybrid granitic rocks; intrusive contact; (4) arkose and conglomerate; unconformity; (5) slate; unconformity (?); (6) granite porphyry; intrusive contact; (7) sedimentary and igneous gneisses; (8) volcanic rocks and derived schists.

The oldest rocks (8) are comparable to the oldest rocks of Pre-Cambrian age found in other areas, but, as they are separated from similar formations by great stretches of granites and gneisses to the east and by the Palæozoic cover to the south, it is not and may never be certain that they are of the same age as the Keewatin rocks of Lake Superior. They consist almost entirely of volcanic rocks of various types. The most common variety is massive, green to greyish-green in colour, and weathers to brownish colour. The ellipsoidal structure figured in so many descriptions of Pre-Cambrian lavas is very strikingly developed, and there are, in addition, certain other typical volcanic forms. Autoclastic bands have been formed by the rolling of the semi-solidified lava and by shearing. Pyroclastic beds are common. They have been formed by the incorporation of bombs of all sizes, from those a foot in diameter down to the finest ash, in the still molten rock. The pyroclastics have, superficially, much the appearance of some of the altered conglomerates of the district. All types, but chiefly the massive lava without the ellipsoidal structure, have been changed, locally, into chlorite schist by pressure and shearing. Some of this alteration occurred before the first period of erosion, since, in the conglomerates overlying the volcanics, there are pebbles of schist which have not been sufficiently deformed by movements affecting the conglomerate to account for their schistose character. Associated with the volcanics there was probably deposited a certain amount of normal sediments, now altered to schists indistinguishable from those of igneous origin.

(7) Outside of the district in which the sulphide ores have been found there are areas of hornblendic gneisses and garnetiferous schists and gneisses that represent in part a sedimentary series apparently overlying the volcanics but with no recognized unconformity. These gneisses are intruded by granite sills and are cut by innumerable pegmatite dykes. The sills and dykes



are believed to be of different ages, some of them older, and some younger, than the conglomerates and arkose that lie above the greenstone series.

(6) There is some evidence to show that one small batholith of granite porphyry is older than at least part of the sediments. The rock has rather peculiar bluish phenocrysts of quartz, and under the microscope shows unusual, irregular, graphic intergrowths of quartz and felspar, similar to intergrowths that occur in granite pebbles from the conglomerate.

(5) A narrow belt of slate has been found bounded on both sides by greenstone schist. No unconformity has been noted between the two rocks, but the slate is lithologically like that lying unconformably above the volcanics farther west.

(4) The first formation that is clearly unconformable above the volcanic complex in the area is a thick series of conglomerate, arkose, and greywacke, now lying in closely folded synclines or as infaulted blocks in the older rocks. The folding following the deposition of these sediments has been so intense that even pebbles of quartz, granite, and quartzite have been twisted, bent, and drag-folded. Some of the lower beds consist largely of debris from the greenstone complex and these have been reconstituted into rocks so closely resembling the igneous original that it is hard to delimit the exact boundaries of the sedimentary synclines. Bedding in the sediments is not plainly marked, but in many places there is a lenticular arrangement, with very sudden variations both in composition and texture. These sudden changes, as well as the mineral constituents of the rocks, show rather conclusively that this series was deposited as outwash fans by rapid streams and probably under arid conditions. The close folding and the faulting that the sediments have undergone make a measurement of the thickness impossible, but it must have been thousands of feet.

(1), (2), and (3). The diastrophic period that followed this final Pre-Cambrian sedimentation was accompanied by intrusions of granite. These took place through a considerable length of time, and the intrusives vary somewhat in character, but are believed to be differentiates from a common magma rather than products of different periods of intrusion. The ore is thought to be genetically related to certain of these differentiated magmas. Texturally, the granitic rocks are massive granite, in places porphyritic, and granite gneisses, faintly banded owing to a concentration of the basic constituents biotite and hornblende. There is no evidence of any great secondary rearrangement, as the longer axes of the biotite foils are not parallel to the banding. In composition the gneisses are practically identical with the massive granite.

There is no evidence that there was further deposition or intrusion nor any very marked disturbances from the time of the invasion of the granite, throughout the rest of the Pre-Cambrian, the Cambrian, and part of the Ordovician. It was probably a period of normal erosion and must have been very long. The great thickness of cover under which the granite batholiths lay was almost completely removed and the mountains of that early period were levelled to a surface much like that at present found in the Pre-Cambrian area. This erosion reached to so great a depth that only the bottoms of the old synclines are left, and in many places where the rocks are not actually granite they are a hybrid dioritic rock formed apparently by the incorporation of basic rocks by the slowly advancing border of the intrusive. The deposition of dolomite during part of the Palæozoic period does not directly affect the consideration of the ores and need not be discussed.

The glacial period was important in that the ice swept away much of the disintegrated material lying upon the rock surface, but it is not likely that it removed any great thickness of unaltered rock. The deposition of lake and stream silts and the growth of muskegs in the undrained hollows have made it rather difficult to prospect much of the area, since the easily altered and eroded sulphides would naturally be removed to form the hollows in the rock floor, now filled with drift.

The geologic history so far as it has been deciphered from the rocks of this district may be summarized as follows: (1) Outpouring of lavas and deposition of volcanic fragmental rocks with possibly some normal sediments; (2) deposition, without any break, of more acidic sediments now recrystallized into gneisses and schists; (3) intrusion of granitic rocks; (4) a long period of erosion; (5) deposition of two series of sediments, the later of which is largely terrestrial; (6) mountain-making with a fairly long period of granitic intrusions during which the ores were brought in; (7) extremely long period of erosion reducing the mountains to a mammillated surface of low relief; (8) deposition of dolomite during the Palæozoic and possibly of shales during the Mesozoic; (9) erosion of these to expose the Pre-Cambrian basement; (10) glacial period; (11) deposition of recent silts and formation of peat deposits.

Ore Deposits.—Two important deposits of sulphide ores have been located, from one of which some ore has already been produced. The Mandy ore-body is on a small point on the west shore of the north-west arm of Schist lake, which drains into the north arm of lake Athapapuskow. The Flin-Flon deposit is on Flin-Flon lake, 4 miles north-west of the Mandy mine. Both are in the volcanic series, but there are marked differences in the character of the country rock and in the structure and mineralogy of the ore-bodies.

The author first deals with the Flin-Flon lens. The country rock to the east of Flin Flon lake is massive greenstone displaying prominent ellipsoidal structure. To the west of the lake the greenstone is massive, dark green, and without this structure. Along a part of the deposit a narrow granite-porphyry dyke forms the hanging wall; west of the ore zone there is a lamprophyre dyke 25 ft. in width. The sulphides occur replacing great shear zones in the greenstone. They form a series of overlapping lenses that unite and divide in a rather intricate fashion, but, as only a small part of the zone is exposed, even the surface plan of the body is not known. Where it is exposed it has in one place a width of 75 ft., but immediately south of this point, it divides around a horse of sparingly mineralized schistose rock. Diamond-drilling on sections spaced at 500 ft. has proved that the sulphides extend for a length of about 2,500 ft. and probably farther. The mineralized zone dips 60° to 70° north-east, and the drills are said to have proved its existence at a considerable depth. The mineralization consists of almost solid sulphides, bordered by disseminations in the wall-rock. In the massive ore the only gangue materials are small blebs of quartz and some incompletely replaced country rock. Pyrite is the most abundant mineral, but along certain zones there are bands of a fine-grained, purplish zinc blende and some chalcopyrite. Gold and silver are present, but only in small quantities.

As regards the Mandy ore-body, the country rock of the point upon which the deposit is situated is dark green in colour, with alternate bands of massive and of schistose rock. The ore-body lies in one of the schistose zones. The ground plan of the body is elliptical, 225 ft. in length by 40 ft. in greatest width. It dips

75° to 80° east. Leading out from the north-west and south-east sides of the lens, there are veins of sulphides striking parallel to the longer axis of the lens and to the schistosity of the enclosing rock. At the north end the ore pinches to a point and pitches beneath barren rock. At this point it is involved in a vertical fault zone that is approximately parallel to the strike of the lens but which does not show in the ore and possibly forms the hanging wall of the ore-body. Glaciation has removed almost all the weathered products from the surface, practically fresh sulphides being exposed by removing the moss. The rocks are slightly stained by copper carbonates and it was this that first drew attention to the deposit. In small fissures in the sulphides, where water is not too abundant, crusts of chalcanthite have formed from the alteration of the copper minerals. The deposit lies in the south-west limb of a syncline, the axis of which is occupied by conglomerate and arkose. The folding of the sediments, consisting of beds of unequal competence, crumpled the weaker beds into numerous drag-folds which, due to the plunge of the syncline northwestward, appear on the surface as shown in Fig. 1. During the intense deformation that these rocks have undergone, the softer beds have suffered thickening at the crests and troughs of the minor folds and thinning along the limbs. There has also been considerable shearing, the greatest amount of fracturing being localized at the troughs and crests of the folds. The surface plan of the ore-body, its supposed form underground (Fig. 2), and its position with reference to the major structure of the country have led to the suggested hypothesis that the sulphide body is a mineralized drag-fold, conditioned by the alternations of massive greenstone and chlorite schist which, squeezed between the more competent greenstone, crumpled and sheared during the folding.

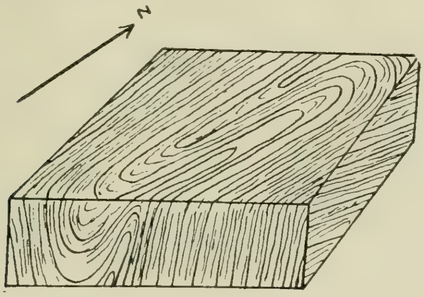


Fig. 1. Drag-Fold on West Limb of Northerly Pitching Syncline.

In the Mandy deposit the varieties of sulphides are individualized in larger bodies than at Flin-Flon. Along both foot-wall and hanging wall the sulphide is almost pure pyrite; the middle of the lens is occupied by chalcopyrite and zinc blende, the former being in a fairly pure band on the foot-wall side. The zinc blende envelopes the chalcopyrite, filling the whole north end of the lens, and there are also interbandings of the two minerals. At the surface the chalcopyrite lens is 10 to 12 ft. in width and 100 ft. in length; at the 100 ft. level it has widened to over 18 ft. Its strike is not parallel to that of the main lens but cuts across it slightly. Gold and silver are both present in the ore, but only in small amounts. The apparently homogeneous chalcopyrite is somewhat lighter in colour than pure chalcopyrite should be, and an analysis gives only 28·96% of copper. Polished specimens show inclusions of material that is black by reflected light, probably country rock taken up by the ores. These inclusions are impregnated by pyrite, and the edges of some of them are granulated and re-cemented by chalcopyrite and zinc blende. The pyrite is clearly earlier than the chalcopyrite since the latter includes fractured and granulated masses of pyrite. Some particles of the pyrite have a square outline, due perhaps to the control of the direction of fractures by the cleavage directions of the pyrite or to the original cubical form of pyrite crystals disseminated in the replaced rock. Specimens also show zinc blende in intimate relationship with chalcopyrite and evidently deposited at the same time as the copper mineral. Where chalcopyrite and zinc blende are interbanded there is no evidence of any fracturing of one with introduction of the other, or of any replacement, but in all cases the chalcopyrite bands contain zinc blende and the zinc blende bands contain chalcopyrite. Fractured and partly replaced pyrite is nearly always present. It seems that there was an early introduction of pyrite which replaced and impregnated the crushed and sheared rock of the drag-folded

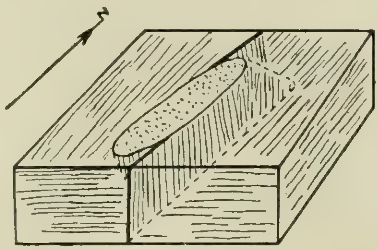


Fig. 2. Diagram of Supposed Underground Structure of Mandy Sulphide Body.

zone of schist. Later movements fractured and granulated the pyrite, and chalcopyrite and zinc blende were introduced simultaneously. The segregation of these minerals into more or less individual zones may have been by selective precipitation due to the character of unreplaced country rock. There are still in the ore fragments of schist even after two periods of sulphide mineralization, and, naturally, there must have been even more unreplaced material before the deposition of the chalcopyrite and zinc blende. Since the country rock was schistose even at the time of the first mineralization, its replacement by pyrite would take place most easily along the planes of schistosity and, where the removal of the rock was not complete, the original schistose structure would be preserved by a banded arrangement of pyrite, partly replaced, and possibly almost unaltered rock. When the later sulphide minerals came in, these zones might so influence the precipitation that the banding would still be retained, but with laminations of chalcopyrite and zinc blende taking the place of the pyrite and country rock of the first sulphide body.

The rocks in the vicinity of the sulphide deposits were originally dioritic in composition, but have undergone great alteration, much of which was probably prior to the period of ore deposition. A massive ellipsoidal-weathering lava from Phantom lake, 2 miles west of the Mandy ore-body, under the microscope shows a porphyritic texture with a few small scattered or nested crystals of plagioclase in a fine-grained groundmass. The crystals still retain the albite banding sufficiently to show that they are near oligoclase in composition. The groundmass consists of small crystals of much-altered felspar together with the products of the complete alteration of the original basic minerals now changed to epidote, chlorite, and calcite. The country rock on the east side of the Flin-Flon lake is still more completely altered, although it retains its ellipsoidal structure. Under the microscope a thin section taken not far from the Flin-Flon sulphide body shows remnants of felspar individuals, but the alteration has gone too far to admit of the determination of their composition. The secondary minerals are chlorite, calcite, and sericite, with considerable secondary quartz. A specimen from the hanging wall of the Mandy ore lens is a fine-grained, greyish, banded rock that effervesces freely with acid. Under the microscope it is seen to consist largely of secondary quartz traversed by a network of calcite. Calcite bands along the planes of foliation are somewhat larger than the connecting veinlets and give the rock a banded appearance. The foot-wall rock is more coarsely crystalline and has a large amount of pyrite scattered through it. In sections of ore, chlorite is the mineral most commonly included in the sulphides. The most striking difference between the rocks close to the ores and those that have not been affected by the ore deposition is the complete or almost complete removal of felspar in the vicinity of the ores, with an increase in the amount of secondary quartz and some increase in the proportion of calcite. The alteration that the original lavas have undergone to change them to the greenstone into which sulphides were introduced, and the additional alteration that the mineralization has produced, are essentially similar, with, however, some silicification during the ore period.

To produce such an alteration it seems necessary that the sulphides should have been accompanied by hydrothermal solutions. Many of the secondary minerals are hydrated, and the presence of quartz and calcite in greater quantities than are found in rocks not affected by the mineralization is most easily explained by the action of aqueous solutions at fairly high temperatures.

The late granites are the most likely source of the ore solutions. An indication of this genetic relation is given by the occurrence of sulphide lenses, although not always cupriferous, along the margins of small bosses and dykes. The silicification of the wall-rocks indicates that the solutions, at some stage of the mineralization, carried quantities of SiO_2, and solutions from a cooling granite mass would be expected to be silicious in character. The copper-zinc ores are referred to the late granite because they have not been crushed or altered by the movements accompanying the late intrusions. Bodies of granite are exposed at the surface at short distances from the ores, and it is possible that the distance to the igneous rock may be even less underground than on the surface.

A STUDY OF CORNISH VEINSTONES.

At the September meeting of the Cornish Institute of Engineers, held at Camborne on September 16, the president, E. H. Davison, read a paper giving the result of his researches into the nature of veinstones in Cornish tin and wolfram mines. We give an abstract of this paper herewith.

The author's results show a certain regularity of variation in the types of veinstone at different depths, relative, not to the land surface, but to that of the granite mass with which the veinstone is associated. These results are in general agreement with some of the views held by Dr. W. R. Jones in his paper read before the Institution of Mining and Metallurgy, and by certain speakers in the discussion which followed it. As regards the author's method of research, each lode studied was first dealt with separately. Specimens were taken from as many points as possible along the dip of the lode. At each point a series of samples was taken across the lode when its full width was exposed. The structure and mineral composition of each sample was noted, and micro-sections were cut from it and used for the determination of the intimate structure of the veinstone and constituent minerals. In certain cases the veinstone was crushed and the mineral fragments examined microscopically, and micro-chemical tests were applied to some of the sections. In addition many isolated samples were examined, both from the old mines now closed down and from working mines.

As a result it seems possible to recognize three types of tin and tungsten veinstone which seem to be related in their distance from the surface of the underlying granite and their proximity to the crests of the granite mass. The types can be recognized as follows:

(1.) Quartz-wolfram lodes: upper level of tin and tungsten zone; occurring in the slate, or just in the granite at, or near, the crest of the mass; little cassiterite, sulphides, or tourmaline; characteristically no chlorite.

(2.) Quartz-chlorite-wolfram-cassiterite-mispickel lodes: middle of tin-tungsten zones occurring in the clay-slate near the granite or for a short distance into the granite; some way off a crest, chlorite predominant over tourmaline, cassiterite usually more than wolfram, sulphides common.

(3.) Quartz-tourmaline-cassiterite lodes: lower part of tin-tungsten zone, occurring in depth in the granite; tourmaline predominant, wolfram absent, sulphides absent or subordinate.

In the following paragraphs particulars are given of the varying deposits as they go down in depth according to the foregoing classification.

The simplest type is well represented in the Castle-an-Dinas wolfram lode. Here the lode-filling consists essentially of clean quartz containing patches of wolfram; there is complete absence of tourmaline and topaz from the lode contents; copper minerals only occur as occasional stains, and the almost complete absence of cassiterite is shown, not only by examination of the lode contents, but also by the fact that the wolfram concentrates obtained on the mine contain less than 0·5% of cassiterite. The lode is worked by means of two adits, and in the lower it is seen to meet a tongue of granite. A granite tongue, possibly the same, also appears in the floor of the upper level, accompanied by bands of greisen. Microscopic examination of the enclosing rock shows it to be a highly tourmalinized clay-slate, occasionally traversed by minute veins of granitic material and sometimes containing scattered crystals of cassiterite which may form the source of the small proportion found in the wolfram concentrates. The lode is worked, and was sampled, in the clay-slate immediately above the crest of the granite surface, and seems typical of the upper part of the tin and tungsten zone. The absence of fluorine and boron-bearing minerals points to its having been filled by the action of hot solutions, but the occurrence of tourmaline and cassiterite in the enclosing rock, and generally in the neighbourhood of the lode, shows that there was an earlier phase of vapour action.

The Castle-an-Dinas lode is an almost unique type in Cornwall, but there are other lodes which seem to represent slightly lower levels in the tin and tungsten zone. For instance, the veins of the Hemerdon Hill stockwork are in many respects similar. They are worked in the superficial portion of the Hemerdon Hill granite, some of the veins carrying quartz and wolfram only, while others carry quartz, wolfram, and cassiterite. The district has been the scene of intense vapour action with the formation of schorl rock, tourmalinized granite, greisen, and kaolinized granite. Kit Hill veins are also of similar character, and contain quartz, wolfram, and cassiterite, with mispickel and some molybdenite and tourmaline. They are at present worked in the granite at a point which is not far below its original surface, so that the three instances given are of veinstones just above, or just inside, the surface of the granite mass.

As regards the second division, the open work at Mulberry shows veins of quartz with wolfram, cassiterite, mispickel, and tourmaline which occur in the clay-slate miles from the margin of the granite outcrop. They may very probably owe their position to a rise in the granite surface, which is borne out by the presence of pneumatolytic minerals outside the boundary of the metamorphic aureole of the main mass.

There is also a lode outcropping on the top of Carn Brea which shows wolfram in clean quartz with mispickel, and which seems very similar to the Kit Hill veins in composition, but is too difficult of access to render complete examination possible.

These veinstones are characterized by the presence of quartz and wolfram, with or without cassiterite and tourmaline, and seem to have been formed toward the upper limit of the tin-tungsten zone, owing their origin chiefly to the action of mineralizing solutions.

The Middle lode, Killifreth mine, shows at one point characters which seem to associate it with this type. In the 40-fm. level the lode fissure appears to have been filled in at least two stages and contains clean white quartz with patches of wolfram and vughy veins of quartz containing cassiterite, mispickel, tourmaline, and blende. Its relations to the granite surface are, however, different, as it lies at some depth in the clay-slate (about 60 fm.) and considerably above the granite surface (a granite tongue is reported to have been met with in the 70-fm. level), and far away from the crest of the granite mass. It seems to belong to the middle of the tin-tungsten zone.

The Rogers lode, East Pool, is of special interest, a typical specimen being seen under the microscope to consist of a coarsely crystalline aggregate of quartz, chlorite, and fluor-spar, with coarse crystals of wolfram, cassiterite, mispickel, and some chalcopyrite. The wolfram is seen to be partly altered to scheelite in some specimens, the decomposition having taken place from outside inward, apparently due to the action of lime-bearing solutions. Along the margin of the altered wolfram, crystals of chalybite appear. The cassiterite is included by the mispickel, while the wolfram appears to have been introduced about the same time as the cassiterite.

It is of interest that in the 190-fm. level, where the granite surface rises toward the east, the wolfram values decidedly decrease as the lode enters the granite.

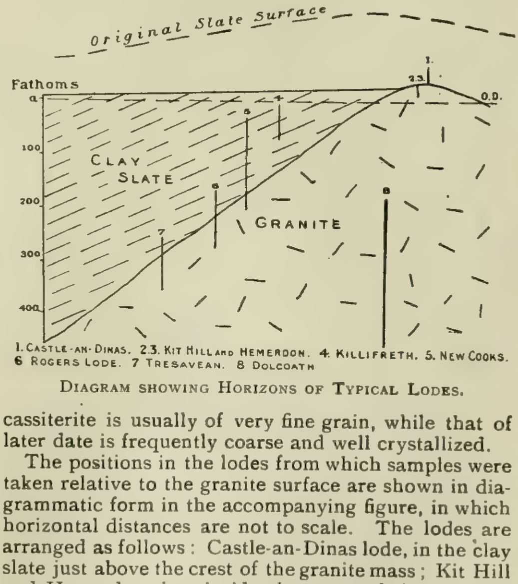
The veinstone of South lode, South Crofty mine, differs from that of Rogers lode in containing little wolfram, being essentially a mispickel-quartz-chlorite lode with good cassiterite values at certain points. Like the Rogers lode the South lode passes from clay-slate into the granite, and the proportion of cassiterite as a rule increases with depth. A characteristic of this lode is the occurrence of idiomorphic quartz crystals, including cassiterite granules of extremely fine grain. Similar inclusions occur in fluor-spar, and these fine cassiterite granules have been noted in several other veinstones of this type.

Tresavean lode has the same general characters as the Rogers lode and South lode, but carries more copper sulphides and only a little wolfram, and shows a preponderance of tourmaline over chlorite. It seems to represent the lower middle part of the tin-tungsten zone.

Wheal Busy lodes also seem to come into this group. The veinstones show quartz, chlorite, tourmaline with mispickel, cassiterite, and some wolfram, and are worked in the clay-slate in association with a quartz-porphyry elvan dyke.

There are also other lodes which show association with this group but do not, so far as is known, contain any wolfram. Such are the lodes of Mount Carbis mine and Tregrehan Consols

The material so far collected from lodes belonging to class 3, worked at considerable depths in the granite, consists of scattered specimens from various mines, but all agree in pointing to a type of veinstone in which quartz and tourmaline are the characteristic minerals, with cassiterite of more than one period of filling, and frequently showing intense brecciation. The earlier



1. Castle-an-Dinas. 2.3. Kit Hill and Hemerdon. 4. Killifreth. 5. New Cooks. 6 Rogers Lode. 7 Tresavean. 8 Dolcoath

Diagram showing Horizons of Typical Lodes.

cassiterite is usually of very fine grain, while that of later date is frequently coarse and well crystallized.

The positions in the lodes from which samples were taken relative to the granite surface are shown in diagrammatic form in the accompanying figure, in which horizontal distances are not to scale. The lodes are arranged as follows: Castle-an-Dinas lode, in the clay slate just above the crest of the granite mass; Kit Hill and Hemerdon, just inside the crest of the granite; Killifreth, in the clay-slate, well above the granite and some way off the crest of the granite mass; South lode, South Crofty, passing from the slate just into the granite, well below the crest; Rogers lode, East Pool, similar to South lode, but passing more deeply into the granite; Dolcoath and Basset lodes, well in the heart of the granite mass.

The author gives a tabular statement of the results of his microscopical examination of veinstones. The specimens came from: Boswin, Grenville flat lode, Mt. Carbis, South Frances, Marriotts West Caunter lode, North Basset flat lode, Basset flat lode, Dolcoath main lode, and New Sump lode, King Edward Williams lode and flat lode, Clitters, Mulberry, Gawton, Wheal Hope, South Crofty Palmer's Shaft, East Pool, Bedford, Wheal Burn, Wheal Vor, West Towan, Parka, Wheal Kitty, Tregrehan.

FLOTATION PRACTICE AT BROKEN HILL.

The *Proceedings* of the Australasian Institute of Mining and Metallurgy, No. 37, 1920, contains a paper entitled "Some Controlling Factors in Flotation," by Ralph D. Nevett. This paper gives much practical information based on the author's experience at Junction North and elsewhere.

The chief controlling factors in a flotation plant fall under the following eight headings: (1) Crushing, (2) rate and regularity of feed, (3) density of pulp, (4) temperature, (5) addition agents, (6) condition of circuit liquor, (7) agitation, (8) aeration.

Crushing.—The ideal feed for flotation treatment is a true slime, but it would not be profitable, as a rule, to continue the crushing operation on crude ore to so great a degree as to make a slime of it. It may be generally accepted, however, that it is bad practice to have any particles remaining on a 40-mesh screen. This is not true in some exceptional cases, as sometimes, for instance, with laminated minerals such as molybdenite and certain copper ores. There are two reasons why the ore requires to be crushed so that all particles will pass through a 40-mesh screen: (1) Because the bubble of air or gas which becomes attached to a particle has not sufficient power to float larger particles of mineral which are produced by any coarser crushing. If, moreover, a bubble of gas were large enough to float a larger particle, the resistance which it would offer to the flow of the pulp would probably cause it to be wiped off and removed from the particle before it had time to reach the surface of the flotation bath. (2) Large particles of ore, when being hurled around in the agitation zone of the flotation vessel, do considerable damage in hindering aeration by cutting bubbles of gas off other particles of mineral.

Rate and Regularity of Feed.—It is essential that the rate of feed going into the flotation plant should be as nearly regular as possible each second of time. There is nothing that interferes so much with treatment as irregularity in the rate of feed and irregularity in the quantity of liquor which passes through the plant from moment to moment. It is a simple matter to make the rate of feed and liquor regular by means of a large agitator or Dorr thickener placed at the head of the treatment vessels. This agitator or Dorr thickener can store quantities of feed supplied to it in an irregular manner by the preparatory plant and deliver it in a regular flow at its discharge to the treatment plant. This storage of slime also enables the flotation plant to be operated continuously through any small stoppages of the preparatory plant.

Density of Pulp.—It is necessary that the feed should be introduced to the treatment plant, in the form of pulp, at a predetermined density which is best suited to the process. The density should be maintained at a regular rate from moment to moment just as strictly as the rate of feed itself. Extensive experiments were made on the dump-material flotation plant at the Junction North mine for the purpose of determining a suitable density and rate of feed. It was found that variations of density had an important effect upon the rate of feed that could be treated. When the density was 56% solids, it was impossible to treat more than 8 tons of dump material per hour, and then only with poor metallurgical results. When the density was reduced to 35% solids, the same plant treated 24 tons of dump material per hour with excellent metallurgical results.

It will be seen from this that the rate of feed and density are allied to each other and complementary, and should be kept under constant control. The folowing is a quick and reliable method for controlling the density of the pulp in a flotation plant: A tin is made to hold 1,000 c.c. of water up to a mark, say, about ½ in. below the top. The tin is dipped quickly into the flowing pulp and filled up to the mark. It is then weighed, using a counterpoise for the tin. The shift-boss or operator should make such a density test at intervals not greater than 15 minutes. The weight of the pulp would be, say, 1,350 to 1,400 grm., which represents about 30 to 34% of solids in the pulp at the dump-material treatment plant at the Junction North mine. If the weight is greater than 1,400 grm. the operator adds water to the pulp as it leaves the Dorr thickener.

Temperature.—With some ores flotation can be carried out in the cold, but a good many ores require heat to a limited extent. Sometimes, with ores containing several minerals, it is necessary to have a little heat for the flotation of one mineral and a greatly increased amount of heat for the flotation of the second mineral. At the dump treatment plant at the Junction North mine in the selective flotation treatment of lead and zinc sulphides by either the Bradford process or the Palmer-Seale-Nevett process, it has always been necessary to watch the temperature of the pulp very closely. In the lead section the most suitable temperature was 89° to 90° F. Even a single degree over 90° F. has been detrimental to the grade of the lead concentrate, as zinc sulphide commenced to float with the lead concentrate with the rise in temperature. In the zinc section the best results were obtained at a temperature of 135° F. with the Bradford process, and at a temperature of 125° F. with the Palmer-Seale-Nevett process. If the temperature is allowed to drop to 130° F. in the former case, the zinc concentrate is not completely floated, and a loss is made in the residues. No benefit is gained by increasing the temperature above 135° F.

Metallurgists like, wherever possible, to treat the ores with as little added heat as possible, to save cost. Wherever heat is required, attempts are made to utilize exhaust steam of engines and other sources of heat, if possible. It is not always possible, however, to make use of exhaust steam in this way, even if it may be available. The favourite method of heating, although perhaps the most expensive method, is by the introduction of high-pressure steam direct from the boilers to the pulp. This way is always very convenient and easy to manipulate, and has quick and effective results, requiring only the operation of a valve from time to time for keeping the temperature of the pulp constant. The ease with which high-pressure steam can be obtained by the operator, and the fact that extra temperature does no harm in zinc treatment, makes it liable to be wasted very considerably. A close watch requires to be kept on the steam consumption in this way, as it might, besides being wasteful in costs, tend to overload the boiler plant if it is otherwise working at high pressure.

Addition Agents.—In all flotation plants it is necessary to add some chemicals. The point at which such chemicals should be added is an important one, and should be determined carefully. It is a matter of vital importance that the valuable minerals in the pulp should be in a properly prepared condition suitable for floating before the pulp enters the flotation machine. For the purpose of ensuring this, it is obvious that whatever chemicals are required should be added to the pulp at least before it reaches the flotation machine. Frequently the purpose will be served if the chemicals are added in the agitation machine, but sometimes it is advisable to add them to the pulp before it reaches the agitation machine.

When acid is required, generally speaking the best place to add it is in the agitation machine, although it may sometimes be added directly to the flotation machine. Frequently acid produces gases, such as sulphuretted hydrogen, by action upon the pulp, which are harmful to flotation, and it is advisable to let these have time to disappear before the pulp reaches the flotation machine.

Oil is not an essential reagent in flotation, but when it is used it should be added far enough back in the flow to ensure its emulsification in the pulp before it reaches the flotation machine. When it is not thoroughly emulsified, oil is distinctly detrimental to flotation. Oil should never be added directly to the flotation machine, but may be added in the tube-mills or other grinding machines, or in the return liquor pump or in the agitation machine, as may be found best in practice.

Condition of Circuit Liquor.—It is usually convenient to employ the ordinary mill-feed water for making up flotation-circuit liquor. The first essential is that this water shall be clean, that is, free from sediment. Such feed water is usually drawn from the underground drainage system, to which has been added some fresh water from the surface rainfall supplies. The mine water would probably contain a certain amount of salts in solution, and in some cases the proportion of salts in solution would render the water unsuitable for flotation. The mill water coming in contact with the ore usually dissolves a good deal of the soluble impurities from it, and by the time the water reaches the flotation plant it might be too heavily charged with salts to make it suitable for acting as a flotation-circuit liquor.

The flotation-circuit liquor requires some properties other than cleanliness to ensure its successful use in a flotation plant, but it is not clear what those properties are. For a long time it was thought that it was necessary to have at least a comparatively large definite quantity of salts in solution, and that this was the main controlling factor in the constitution of a good circuit liquor for flotation. From many tests carried out at the Junction North mine, it would appear even yet as if the quantity of salts, and kind of salts, in solution exerted an important influence on the flotation operation. It was noticed sometimes, when the flotation plants were not working well, that the quantity of salts in solution had either dropped below 1,400 grains per gallon or had risen above 2,600 grains. It would seem from the various tests that the best results were obtained when there were about 2,000 grains of salts per gallon in the solution. The salts were mainly salts of manganese, zinc, iron, and calcium. It would be a very difficult matter to carry out a set of tests either in the laboratory or in an operating plant to prove the effect of salts in solution. The ore itself containing soluble salts would, as soon as it comes in contact with pure water, immediately provide some salts in solution.

A good deal of work has been done at the Junction North mine and by other investigators to endeavour to determine the actual effect of certain specified salts in solution, and a good deal of interesting information has been collected ; but it has never yet been shown that any of the common salts which naturally go into solution in the Broken Hill treatment have a very marked influence upon results, unless present in excessive quantities, and none of the salts known to exist in the circuit liquors in Broken Hill have anything like so great an influence upon the treatment as to explain the reason why some flotation liquors are energetic and others dull in their action. It is distinctly noticeable, when flotation work is going on successfully in the plant, that the flotation liquor has some property which has never yet been thoroughly defined, and it seems to be a physical property denoting energy which has been instilled by some means into the circuit liquor. Sometimes the nature of the liquor can be corrected by alteration to the oiling, sometimes by alteration to the application of acid. The Palmer-Seale-Nevett process claims to correct the conditions of the liquors in many cases by addition of elemental sulphur.

If oil exists in the circuit liquor it must be emulsified. Free oil is very detrimental to flotation work, as can easily be seen in the Cascade process. If a few drops of oil are admitted to the first Cascade vessel its effect will be seen on each of the following Cascade vessels of the series in killing the float which was just previously there.

Agitation.—Agitation is beneficial in all methods of flotation of all classes of ore. Some classes of ore, however, do not require so much agitation as others, and calcitic ores treated by purely acid processes usually require only a moderate degree of agitation before treatment. The quantity of calcite present in the ore need not be more than a few pounds per ton. The acid readily sets free the CO_2 gas which, being nascent, rapidly attaches itself to the mineral particles and floats them. The intimate association of the calcite in the ore ensures successful gassing. Such ores as do not contain calcite or any other carbonates require treatment by agitation-aeration, by which the atmospheric air is beaten into the pulp, to cause the attachment of bubbles of air to mineral particles. The Minerals Separation machine was originally designed for this purpose, and later on the Owen patent and Lyster patent showed other means by which it could be carried out more effectively and more completely. The agitation should be carried out in the treatment vessel so that the mineral can rise to the surface of the vessel and be removed without having to travel a greater distance than is absolutely necessary, or, in other words, to avoid overtaxing the ability of the bubble to retain its hold on the mineral particle for leading it out of the flotation bath.

The author is, however, strongly in favour of providing some kind of machine at the head of the treatment ; for instance, a vortex mixer or a Minerals Separation mixer, or a larger agitation machine, to provide that the pulp shall be thoroughly agitated and partly aerated before it enters the treatment vessel. This pre-agitation aeration incorporates oils, reagents, acids, &c., and probably causes some beneficial effect by oxidation of some of the substances, and so saves the first-treatment vessel from being wasted on this work. It might be, too, that some deleterious substances are formed immediately upon application of the acid and reagents, such as noxious gases like H_2S, which, in this preliminary partial agitation-aeration, are either driven off or altered to make them innocuous ; and in this preliminary agitation machine chemicals or acid or perhaps oil may be added, the temperature being controlled so that when the pulp enters the flotation machine it is ready for separation of the valuable minerals. It is even advisable to add the chemicals or oil or acid to the pulp before it enters the preliminary agitation machine.

With some simple ores very little agitation is required before the pulp passes to the flotation machine, and, in such cases, if the pulp is lifted by bucket elevators direct to the flotation machine, sufficient agitation will be provided by the elevators for successful separation. In that case the chemicals and other reagents may be added, perhaps, at the boot of the elevator. The bucket levator may be looked upon as a first-class agitator, although the period of agitation provided by it is very short.

If the pulp requires much acid or heat added to it, it is advisable to have the agitation vessel at the head of the flotation machine besides the elevator, because in such cases the elevator belt would suffer severely if it handled hot or acid liquors.

Agitation is always beneficial to flotation, and in most cases it is absolutely necessary. It has a cleaning effect on the particles, and, if oil is used, causes a greater emulsification and distribution of the oil. To ensure a more complete flotation of the particles, it breaks up the bubbles of air and distributes them in a very free state of division throughout the pulp in such a manner as to give every particle of mineral a chance to become attached to air bubbles.

Aeration.—Aeration means the introduction of air into the pulp in a finely-divided condition so as to form a froth, in order that the particles of mineral may become attached to finely-divided air bubbles, by means of which they are floated up to the surface of the flotation bath and removed across the periphery as a separate concentrate. Air for aeration was originally introduced into the Minerals Separation machine by being sucked down to the impeller from the surface through the vortex and disturbance caused by the agitation. The quantity of air so converted into froth was always indefinite and not under control, and for this reason flotation results were very changeable. It was necessary to have the agitation-aeration zone in another vessel separated from the flotation bath, because the latter required a quiescent surface, which could not be provided by the former. This was a very severe handicap, as it required the bubble to travel a very great distance before it could be rescued at the surface; consequently, only the most powerful methods of flotation could be used with it, such as would develop combined flotation and not permit of any selective action.

It was found by Owen that if agitation-aeration were carried out in the flotation bath itself the bubble would have a very much shorter travel, and much more delicate flotation work could be carried out. The effect of this was to permit of selective flotation on one mineral in preference to another. By means of the Owen process, air was either sucked in by impellers or pumps, or was introduced as compressed air and delivered to the impeller in such a manner that it could be most effectively beaten up into a foam.

Later on, at the Junction North mine, it was found that definite control could be obtained to govern the quantity of aeration introduced into any pulp, and measurements could be obtained of the amount of aeration by means of a steelyard or an ordinary water-gauge tube, graduated and placed outside the flotation vessel and connected with it. It was afterwards found, by means of the Cascade process, that aeration could be adequately obtained by means of entanglement with pulp as it fell down open pipes.

It is essential that the air should be completely atomized in the pulp and not allowed to be distributed through the pulp in the form of comparatively large bubbles. This must be carefully watched when aeration by compressed air is adopted. If the supply of compressed air is too great through any one delivery pipe, then the air is distributed throughout the pulp in the form of large bubbles, which are unsuitable for flotation. These large bubbles float rapidly to the surface and disturb the quiescent zone, so that some of the float already there is caused to sink again and some of the gangue is caused to overflow the periphery and spoil the concentrate. Compressed air must be added in such a way that it enters the pulp in the maximum zone of agitation of the impellers. The force of agitation at that point will determine the amount of air which may be effectively taken from the supply pipe. If it is desired to atomize a still greater quantity of air than can be dealt with from one supply pipe, it is possible to gain such an increase in any particular flotation machine by increasing the number of air supply pipes around the impellers or by increasing the speed of the impellers.

In the Cascade process the air is drawn in and entangled by the pulp as it drops down the vertical pipe and becomes atomized by the splashing of the pulp in the impact, which occurs when the pulp hits the surfaces of the liquor and metallic parts of the flotation machine. It is generally advisable in the Cascade process to have a cup placed below the bottom of the vertical pipe to intensify the impact.

Electrolytic Zinc.—At the meeting of the British Association held at Cardiff, Professor Samuel Field read a paper on the electrolytic zinc process developed by him at the works of British Metals Extraction Co., Ltd., Swansea. During the war a large amount of this zinc was sold for munitions purposes, obtaining a substantial premium in price. Mr. Field's researches have been centred on the cumulative effects of minute amounts of nickel and cobalt in the electrolyte and methods of removing these injurious constituents.

The ore, after roasting, is treated with the acid zinc sulphate liquors from the cells. The formation of gelatinous silica is avoided by boiling the solution with an excess of whiting. The crude zinc sulphate liquor after filtration contains about 10% of zinc with quite small but unallowable amounts of arsenic, antimony, copper, cadmium, iron, cobalt, and nickel. A typical composition of this unpurified solution is: Zinc, 10·0%; copper, 0·05%; cadmium, 0·03%; manganese, 0·10%; iron, 0·05%; cobalt, 0·001 to 0·01%; nickel, 0·001 to 0·01%; together with small amounts of arsenic and antimony. The effects of each of these impurities on the subsequent process of electro-deposition have been studied in detail.

Copper, arsenic, and antimony pass into the zinc deposit with low acidity, and with an increase of acid and temperature (normal conditions) set up a powerful corrosion, leading to the almost complete re-solution of the deposit. Iron does not pass appreciably into the deposit, but oxidation and reduction at the anode and cathode reduces current efficiency, and thus increases power consumption. Cadmium passes almost completely into the cathode zinc, and gives rise to marked brittleness. It is indeed possible to compute the percentage of cadmium in the cathode zinc from its proportion in the liquors.

Nickel and cobalt, when present in the liquors, are individually responsible for characteristic types of intense corrosion without ultimately entering into the composition of the cathode zinc. It has been recognized that these metals are two of the most insidious and cumulative impurities, cumulative in the sense that, not being removed by simple processes usually adopted, they accumulate in the liquors with disastrous effects upon the subsequent electrolysis. Their presence in only a few parts per million of liquor may completely wreck the deposition process. Simple methods of purification fail to eliminate these metals. Thus the detrimental effects of these impurities necessitate their almost entire elimination by special methods of purification. Of nickel, it has been placed on record that "a minute fraction of 1% in an ore would render that ore untreatable by the electrolytic process, and that the removal of that nickel constitutes a most complex chemical engineering operation."

The author proceeds to give an outline of the new methods which have been devised to deal with the normally small quantities of the impurities present. These methods secure the elimination of all harmful impurities in even one operation, or at most two.

In a three-stage purification at first used, iron, arsenic, and antimony were removed by the addition of whiting and agitation with air. The precipitation is best effected at elevated temperatures, and the precipitate, which contains some zinc hydrate, may be used in reducing acidity in the extraction process, thus saving the zinc content. Copper and cadmium are normally supposed to be removed by simple treatment with zinc in a finely divided form. This process, however, fails to reduce the cadmium to an allowable quantity for a 99·95% product, and has practically no effect on nickel. Nickel, and with it copper and cadmium, can be completely eliminated by zinc dust in a faintly acid solution and with agitation at an elevated temperature (see British Patent No. 138,947, 1918) and after filtering. Cobalt is removed by treatment of the liquors with lead peroxide or the lead-manganese peroxide mud from the electrolytic cells (see British Patent No. 138,948, 1918). This so far covers the purification which has been used in the earlier stages of the author's work. Alternative and even more rapid and economic methods have since been worked out, and these are briefly indicated by the author in the following paragraphs.

Of the usual impurities, iron, cobalt, arsenic, and antimony are essentially eliminated by oxidation, iron being oxidized to ferric and bringing down with it the arsenic and antimony as basic arsenate and antimonate. Very narrow limits must be set on the character of purification reagents, as nothing must be introduced which will, if it remains in the solution, adversely affect subsequent deposition. A large number of oxidizing agents are thus definitely barred, such for example as hypochlorites, as these leave chlorine which would lead to a very pronounced anode disintegration. Ozone is an exceedingly cheap and effective oxidizing agent. Passed into the hot zinc sulphate solution, to which a little whiting or limestone is added, iron and cobalt are readily and completely oxidized, and simultaneously arsenic and antimony come out (see British Patent No. 138,946, 1918). In this process, manganese, which is almost invariably present in crude zinc liquors, acts catalytically as a carrier of oxygen. In its absence, it can be added even as a manganous salt.

The elimination of copper, cadmium, and nickel is essentially a process of reduction. Normally, zinc powder is the reducing agent, and the action being electrolytic is greatly facilitated by slight acidity. But the zinc-copper couple is a well-known reducing agent, and doubtless acts in that capacity when zinc powder is added to solutions containing copper. Normally the elimination of cadmium and nickel was found to be facilitated by the addition of copper if this metal was absent from the solution. Further, however, the well-known couple of aluminium and mercury has powerful reducing effects arising from their wide divergence of electrochemical properties of the two metals, combined with the advantage of over-voltage effects of mercury. Amalgamated aluminium most effectively removes every impurity (see British Patent No. 138,950, 1918) save perhaps iron, and aluminium passing into solution in quantity chemically equivalent to the impurities removed has no detrimental, but perhaps rather beneficial, effect upon zinc deposition. Still alternatively, amalgamated zinc in any convenient form may be used, dispensing with the use of aluminium. As a further simplification, the purification can be very effectively accomplished by the addition of small amounts of mercuric sulphate to the slightly acidified liquor, followed by the usual addition of a predetermined amount of zinc powder.

Finally, it has been found possible to eliminate the whole of these impurities in the extractors, and this has been accomplished in the following order: Acidity is reduced down to 0·4 or 0·5% by ore and then by available zinc precipitate down to 0·2% or less. Mercuric sulphate in small and economic quantity is added, followed by zinc powder, thus eliminating copper, arsenic, antimony, cadmium, nickel, and cobalt. The solution is then over-neutralized by limestone or whiting, and agitated, with boiling and by air or ozonized air for a short time to overcome gel troubles and eliminate iron. Subsequent filtration has given a liquor at once available for deposition for a product yielding over 99·92% zinc. Circumstances will dictate the most suitable variations or combinations of these alternate methods of purification.

Richard Trevithick.—At the annual general meeting of the Institution of Mining Engineers held at Manchester last month, J. Harvey Trevithick read a paper on the life and inventions of his great-grandfather, Richard Trevithick.

Richard Trevithick was born in 1771 at Illogan, near Redruth. His father was at the time manager of the Dolcoath mine and mineral agent for the Tehidy Estates. When his father died in 1797, he succeeded him as engineer to a number of mines. He went to school at Camborne and afterward devoted most of his time to the mechanical problems connected with mining. In particular he experimented with the steam engine, firstly in connection with pumping and other similar applications of power, and afterward he paid attention to the devising of a locomotive.

Trevithick was the first to apply steam at high pressures. Watt was his greatest opponent, being a strong advocate of low-pressure steam; indeed, he was so strongly opposed to the use of high-pressure steam that he tried to get a Bill passed by Parliament to stop Trevithick from making such engines on account of danger to the public. There seems, however, to have been only one recorded serious explosion, but Watt made most of this to strengthen his opposition. The two inventors were engaged in patent litigation for many years. Trevithick, nothing daunted, and convinced that high-pressure steam was the correct thing and the most economical in working, invented the single-flue or Cornish boiler, which is cylindrical in shape and had a cylindrical flue inside.

How rapidly his idea of high-pressure steam developed is proved by the fact that in 1813 he supplied boilers, 40 ft. long and 5 ft. in diameter to work at a pressure up to 100 lb. per square inch, a remarkable fact in view of the manufacturing limitations in those days. In 1797 he introduced the plunger-pole pump, to take the place of the old wooden mine pumps that had barrels hooped with iron, with a packed bucket inside containing a valve. Much trouble was experienced with these pumps owing to sand-jamb. Trevithick's invention is the now well-known plunger-pump, with the plunger working through a stuffing-box, but quite free from the casing. In the following year came the invention of his water-pressure engine. In 1798 he introduced his high-pressure puffing-engines. These engines were naturally less bulky than the low-pressure vacuum-engines, both as regards engine and boiler, and this feature enabled him to construct a portable type, one of which was sent to London to work. In 1800 he built his first high-pressure expansion condensing winding-engine at Cook's Kitchen mine. The cylinder was double-acting, and the steam-pressure 25 lb. above that of the atmosphere. This engine had a crank, which was introduced probably for the first time, to give motion to the shaft. With its 19 in. cylinder and 5 ft. stroke, it was a standard type of beam-engine for nearly a century.

The invention of the high-pressure steam-engine made the locomotive possible, for the huge bulk of the low pressure cylinders and boilers and the larger quantity of water required for condensing purposes were quite prohibitive on wheels. For some three or four years Trevithick had been engaged in scheming out the problem, and his first model, made in 1797, is now in the South Kensington Science Museum. It consisted of a horizontal cylindrical boiler with a vertical steam cylinder let into the top at one end; connecting-rods from a cross-beam communicated the motion through cranks to the road wheels. A flywheel was attached to carry the engine over its centre. In 1801 he brought out his first practicable locomotive. It consisted of a sort of Cornish boiler, but with a return flue; the steam-cylinder was embedded vertically in the boiler at one end, and the motion was transmitted through head connecting-rods to cranks on the road wheels. The following are notable details: A fusible plug in the flue to prevent damage from shortness of water in the boiler; bellows worked by the engine to create a draught; an exhaust in the chimney for the same purpose; and a feed-water heater. In order to ascertain whether there would be sufficient adhesion between a smooth wheel and the road, he had experimented with a heavy carriage by causing it to go up a steep hill by turning its wheel round by hand. This first locomotive, which was built in a small smithy in Camborne with a plant consisting of a 1 ft. lathe and two smith's fires, made its first trial on Christmas Eve, 1801. This trial is described by Stephen Williams, one of the passengers, as follows: "When we saw that Captain Dick was going to turn on steam we jumped up as many as could, may be 7 or 8 of us. 'Twas a stiffish hill going up to Camborne Beacon, but she went off like a little bird. When she had gone about a quarter of a mile, there was a roughish piece of road covered with loose stones; she didn't go quite so fast; as it was a flood of rain, and we were very squeezed together, I jumped off. She was going faster than I could walk, and went on up the hill about a quarter or half a mile further when they turned her and came back to the shop." Several trials were made, and finally the engine was upset and hopelessly damaged. A result of the trials was an application for a patent, which was granted to Trevithick and Andrew Vivian on March 24, 1802.

The road-locomotive which Trevithick constructed in 1803 had two rear wheels about 9 or 10 ft. in diameter and one front steering wheel. After testing this at Camborne, it was taken to London, and there are several accounts by eye-witnesses of its running along the street, sometimes at from 9 to 10 miles an hour, although difficulty of steering often got the owners into trouble. Captain Vivian, the father of Trevithick's partner, had a ride on it, but thought he was much more likely to suffer shipwreck on it than on board his own ship. Finally, funds running short, the engine was sold and became a hoop-iron rolling-mill engine. The experience which Trevithick gained from the trial of this engine proved to him conclusively that a smoother road, made of iron, was necessary to enable the best running results to be obtained, and from this time onward he devoted his attention to the form of engine which ultimately led to the modern railway-locomotive. In 1804, at Merthyr Tydvil, South Wales, he built and set to work his first tramway-locomotive. This pulled a train a distance of about 10 miles, at the rate of 4 miles an hour. It drew a load of 25 tons of material and carried several passengers. It had smooth driving wheels, but the rails were flanged in order to keep it on the track. In the latter part of 1804 he had another locomotive running at Newcastle-upon-Tyne. This engine had flanged wheels and ran on plain-top rails, the universal practice to-day.

In 1808 he was busy on an improved engine, which he called "Catch me who can." In conjunction with this locomotive he constructed a circular railway in London, on the spot where Euston Station now stands. This locomotive weighed about 10 tons, and could obtain a speed of nearly 12 miles an hour. For several weeks it was exhibited and ran on this circular railway, a charge of 1s. being made per passenger. One day, however, a rail broke, and the engine left the road and turned over. By this time he had exhausted all his means, and was obliged to give up his endeavours of trying to convince the public of the enormous advantages to be gained by the use of the locomotive.

His other work was various and his ideas multitudinous. In 1801 he erected an engine at Tredegar Iron Works for operating large rolls for puddling. This engine remained at work up till 1856. In 1803 he constructed what was undoubtedly the first steam dredger, which was used to dredge the East India Docks. This dredger worked for 10 years. Afterward he was engaged in an unsuccessful attempt to construct a tunnel under the Thames at Rotherhithe. He fitted a ship with a paddle wheel for propulsion by steam. The steam winch was an invention of his about the year 1805. It is on record that he had steam threshing-machines and steam ploughs at work in 1813. Other inventions included an improved recoiling gun-carriage, an artificial ice-making machine acting on the expansion of compressed air, the steam surface-condenser, hot-air heating apparatus of a portable type, and the chain-and-ball pump.

In 1813 an event occurred which brought about a break in his career. A man of great influence in Lima, Peru—Don Francisco Uville—came to England to see whether he could obtain engines for pumping water in the Peruvian mines. He consulted Boulton and Watt, who discouraged the idea, as they said that the engines would have to be carried in small sections on mule-back over the mountain-paths to the mines, a feat that would be quite impossible on account of the huge dimensions of these low-pressure vacuum-engines. These were the only ones made by them, as Watt was always opposed to high-pressure steam. Don Francisco Uville, who was not at all pleased with the interviews that he had with Boulton and Watt, came in despair to London, where one day when passing Fitzroy Square he chanced to see in a shop-window the model of a steam-engine, which he found on inquiry worked with high-pressure steam without vacuum or the necessity for any condensing-water. He purchased the model for £20, and at once returned to Peru. On his arrival he took the engine some thousands of feet up into the mountains, and to his great surprise found that it worked perfectly. He again returned to England, and on making careful inquiries found that Trevithick was the inventor of this high-pressure engine. In a little over a fortnight he had placed orders with Trevithick for six engines complete with pumps. The cylinders of these engines were 24 in. in diameter by 6 ft. stroke, and the pumps were 12 in. in diameter. The conditions were that the engines had to be despatched within four months. These conditions were fulfilled, and Don Francisco Uville persuaded Trevithick to come with him to Peru to erect and start his engines, with the result that he sailed for Lima on October 16, 1816. He remained in South America for about ten years. He was in Peru up to 1822 erecting engines, all of which worked with great success. In this year civil war broke out, which upset all the ambitions both of Don Uville and Trevithick. All the machinery was destroyed by the insurgents and thrown down the mine shafts, and Trevithick left Peru, sacrificing all his prospects of great wealth and apparently losing all that he possessed. From Peru he made his way to Costa Rica, where for the next five years he had a most adventurous time among the copper mines. During these five years he said that he had been half drowned, half hanged, and the rest eaten by alligators. In 1827 he returned to England in a sailing-vessel, without a penny in his pocket; in fact, he had to borrow £50 from Robert Stephenson to pay his passage home.

For some time before his death in 1833, he had been engaged at the works of John Hall, at Dartford, now J. & E. Hall, Ltd. It was at these works that he and John Hall constructed and developed what is known as Hall's condenser.

With all his genius he never made money and died a poor man. He was, undoubtedly, in advance of his day. Succeeding generations have recognized the value of his services in introducing the locomotive and the high-pressure steam engine.

Magnetic Surveys.—In the issue of October, 1918, we quoted a paper by T. Lindsay Galloway, read before the Institution of Mining Engineers, describing a method of determining the magnetic meridian as a basis for mining surveys. At the meeting of this Institution held last month, Mr. Galloway supplemented this paper with the following note:

The magnetic reflector described in the previous paper provides the surveyor with a portable magnetometer that is able to show the direction of the magnetic meridian with a degree of accuracy comparable with that of the instruments in a magnetic observatory. Its indications, however, are necessarily subject to the same hourly and daily changes as the earth's magnetism itself, which, while following approximately a certain daily cycle, is liable to disturbances of an irregular kind. In these circumstances, the relative direction of two reference-lines or bases may be ascertained by making a series of observations on each line on successive days, at corresponding hours, and comparing each with each. By multiplying the number of observations, so as to provide against chance irregularities, a high degree of accuracy may be obtained. But this method still leaves something to be desired in point of exactitude. When great precision is required, as, for example, in setting out the principal base-lines underground in a new mine, in setting away a main haulage road, in laying down the centre-line of a tunnel so that it may be driven from each end or from intermediate points simultaneously, or in important surveys of any kind, the following method will be preferable. Two magnetic reflectors must be employed. They must, first of all, be compared together, in order that any difference arising from the non-parallelism of the mirrors and magnets, each to each, if such exists, may be ascertained, and accurately measured. This may be called the instrumental correction, and the mode of determining it will be described later. The two reflectors and two theodolites must now be set up on the reference-lines the relative directions of which are to be ascertained. At a certain prearranged time two observers, one at each place, must note the magnetic bearings of the two lines. The difference between the bearings, after applying the instrumental correction, will give the relative direction, or angle, between the lines. As a check on the accuracy of the result, other pairs of simultaneous observations may be made at any other prearranged times. During the intervals the direction of the magnetic meridian may undergo any changes whatever, regular or irregular, so that the observed bearings may no longer be the same. But whatever may be the changes, they will affect both instruments equally. Consequently the difference between any pair of simultaneous bearings ought to be precisely the same throughout. Thus, as no allowance requires to be made for the fluctuations of the direction of the magnetic meridian, that source of uncertainty and possible error is entirely excluded. If one of the reference-lines is on the surface and the other underground, it is assumed that the direction of the meridian is the same above and below ground. This supposition is doubtless correct in all ordinary circumstances. But, when a violent magnetic storm is in progress, the presence of earth-currents may possibly interfere; and until this point has been settled, the period of a magnetic storm should be avoided.

It remains to describe how the instrumental correction is to be determined. One of the reflectors is set on a tripod and a theodolite is placed directly in front, so that the image of a plumb-line suspended beneath the centre of the theodolite can be seen reflected in the mirror. The horizontal vernier being set to zero, the theodolite must be turned till the cross-wires in the telescope coincide exactly with the image of the plumb-line. The reflector must now be removed from its tripod, and the other reflector substituted for it on the same tripod. If the cross-wires do not now coincide with the image of the plumb-line, the horizontal tangent-screw must be turned until they do coincide. The angle now recorded is the instrumental correction which must be added or subtracted, as the case may be, in ascertaining the comparative bearings of two lines, as already described.

Lost Canadian Placers.—The August issue of the *Bulletin* of the Canadian Institute of Mining and Metallurgy contains a brief paper by A. P. Coleman, professor of geology in the University of Toronto, on the lost placers of Ontario. He refers particularly to the fact that at Porcupine the gold lodes were not discovered through surface gravels. Dr. Coleman and others have suggested that former placer deposits may have been swept away by glacial action during the Ice Age and mixed up with barren materials to such an extent as to be lost. There are some facts that appear to support this theory, the most important being the finding of gold for about forty miles along what have been called the Vermilion placers to the south of the Porcupine region. At several points along this stretch, colours of gold can be panned, sometimes even a hundred or more, but so fine as often to be visible only with a lens. The largest nugget found during several days' panning had a value of only four cents. These deposits are in glacial materials more or less assorted by lake action; old river gravels have not been found and bedrock has not been reached in the small amount of sluicing done during the short-lived placer boom. It is possible that this gold was brought by the ice-sheet from the Porcupine district about ninety miles to the north; but, if so, the coarse gold of the quartz veins must have suffered tremendous grinding to be reduced to the fine dust of the Vermilion placers. On the other hand it must be remembered that Porcupine is hundreds of feet lower than Meteor lake, where the most northerly placer gold is found, so that rivers could not have transported gold in that direction. On the contrary the drainage is, and probably always has been, to the north toward James Bay. Placer deposits resulting from the weathering and destruction of the gold bearing rocks of Porcupine must have accumulated along the drainage slope to the north and not toward the watershed to the south. If such placers were formed, they may have been completely destroyed, or there is a possibility that portions of them still remain. If they remain the question is, where should they be looked for. First perhaps it is desirable to inquire as to the original magnitude of such placers. Porcupine has already supplied more than $50,000,000 worth of gold, and one mine reports reserves valued at $40,000,000. The probable total production of the region should run into hundreds of millions of dollars, as some of the veins are known to reach a depth of 1,500 ft. or more. The rocks of the region show steeply tilted, often vertical, structures, and it may well be that the gold-bearing veins originally extended far above the present level. The mines now being worked may represent merely the lower half of the deposits as they were formed in the beginning, and it is certain that hundreds if not thousands of feet of rock with the enclosed quartz veins have been destroyed by weathering and superficial erosion. It may be inquired what has become of the hundreds of millions of dollars' worth of coarse gold set free in that way. The major part of this destruction took place almost certainly before the deposition of the Cobalt series, when the mountains due to the Algoman elevations were reduced to a peneplain. It is possible that the Huronian Ice Age swept away these earliest placers; but residual materials underlie the tillite at various places, as shown by Miller and Knight, and it may be that remnants of the pre-Huronion placers still remain somewhere beneath the conglomerate. However, there has been great erosion of both Huronian and older rocks in the vast period of land conditions since that time, so that Palæozoic, Mesozoic, or Tertiary placers may have been formed on the slope toward James Bay, and may still remain in places beneath the sheets of stratified clay which cover so much of the region to the north or beneath the Palæozoic rocks on the shores of James Bay or even beneath the Cretaceous sediments found by Keele under the boulder clay on some of the rivers. The purpose of Dr. Coleman's paper is to call attention to the fact that in Northern Ontario perhaps half of the original gold-bearing quartz has been destroyed, setting free enough gold to form more than one Klondyke, and yet no placers of importance have been found. If such deposits still exist they are probably to the north of the Porcupine region and buried beneath later sediments. They may occur beneath any of the sedimentary rocks from Pleistocene clay to Huronian conglomerate, and as they may be disclosed somewhere in the river valleys on the Hudson Bay slope, explorers should be on the look-out for them.

Diamond-Drilling in a Glacier.—*Mine and Quarry* for July contains an article by A. S. Williamson, manager of the Lucky Four Mines, British Columbia, describing his adventures in connection with a Sullivan diamond-drill operated from within a glacier.

The Lucky Four Mines, at Laidlaw, British Columbia, are situated 16 miles south of the Fraser River at the head waters of Jones Creek on the Cheam Range. The outcrop is at an altitude of 5,750 ft. on a glacier. The author received instructions on February 1, 1919, to take in a diamond-drill and 20 tons of supplies and start operations. First he located a trail by blazing through the timber. Once above timber line he used small flags. There were two miles of trail above the timber line. The next was the hardest problem, how to make a snow trail that would stand up under horses, as there was 12 in. of snow at the Fraser River, 13 ft. at Jones Lake, 2,000 ft. altitude, and 30 ft. at the place picked out for a camp site, 5,550 ft. up on a ridge.

He had received all kinds of suggestions how to get in. Some said it could not be done. However, he got the trail gang to tramp solid the trail in one-hundred-yard sections; then he followed up with a light horse and go-devil, the go-devil made entirely of vine-maple with the runners curved toward the centre in the front so that it would follow the curves of the trail without cutting into the snow on the sides. The trail was not over 18 in. wide. After two or three trips with the go-devil loaded up to 300 pounds he could load up to 700 or 800 pounds with one horse. He established camps every five miles and got in with the supplies, without any difficulty, to the camp site within one mile of the mine, which was 1,000 ft. or over above camp on the glacier.

Then they dug down through 30 ft. of snow to bedrock and put down three tents with split cedar for floors and four-foot shakes all around for sides. The next question was, how to get the diamond-drill with its equipment on to the glacier. This equipment included three poles for the tripod, 23 ft. long, petrol, tools, etc., including a zinc tank 5 by ½ by 3 ft. to melt snow in order to get water for the drill, as there was no water on the glacier. By this time the snow was getting very soft and it was impossible to make a trail from the camp to the mine that would hold up horses. So the trail was tramped good, switch-backing up over the glacier, then 14 men were put on a rope attached to the go-devil, who took the drill up in two sections, first the drill portion and then the petrol engine; also the supplies and heavier portions were hoisted by go-devil; the petrol was back-packed.

While the trail was being built and supplies coming up a place to put the drill up was being dug on a ridge below the outcrop. This was accomplished by digging out a cut across the ridge 5 ft. wide by 35 ft. deep and 50 ft. long, afterward cutting out a space 25 by 25 ft. to place the drill in. After getting the drill set up, the place was made as comfortable as possible by a large tarpaulin put over the tripod and machinery, very much like an Indian tepee; this was heated with oil stoves, which also melted the snow in the big tank. Drilling was started with three shifts. After drilling one hole 700 ft., it was attempted to drill a hole to the right at an angle of 15° to the west of the first hole, but glacial ice was encountered after going 60 ft. Repeating the performance to the east, in 35 ft. ice was run into again.

As there was no other possible place to approach the ore-body except by going down the mountain several hundred feet and putting in holes, the shortest of which would have been 1,000 ft., it was decided to try putting the drill into the glacier within two or three hundred feet of the ore-body, and cross-cutting it. In order to find out how deep the ice was and what the bedrock looked like, the author drove a tunnel 4 by 6 ft. through the ice to bedrock, a distance of 80 ft. Knowing the thickness of the ice and the slope of the bedrock (about 30°), he started an open-cut 4 ft. wide parallel to the tunnel. After driving 80 ft. bedrock was struck. There he cut out a place for the drill, 22 by 22 feet, levelling off the bedrock in order to give a foundation for the drill. At this point there was 50 ft. of solid ice above the drill.

The question then arose of getting the drill up to its new position from its old set-up about 400 ft. below. It was decided to make the drill pull itself up over the glacier. So a set of blocks and tackles was rigged up and dead-men put in every 50 ft. in a trench in the ice. Using the carriage on which the drill and gas engine were placed as a sleigh, inside of two hours the whole outfit, drill and engine, was standing on the dump ready to haul up a go-devil loaded with petrol and later all the supplies from the old position. Once this was accomplished the drill and engine was made to pull itself right into the face. In two days it was possible to start drilling in good shape.

SHORT NOTICES.

Deep Mining.—The *Engineering and Mining Journal* for August 28 gives an abstract of a Government report by R. R. Sayers and D. Harrington on the physiological effects of high temperatures and humidities in metal mines.

Electric Prospecting.—The *Industrial Australian and Mining Standard* for August 5 describes work done by a system of "wireless" in prospecting for lodes. The company owning the process is Electrical Mine Surveys Proprietary, Ltd., of 339, Collins House, Melbourne, and the example given in the article was in connection with the Indooroopilly silver-lead mines.

Gold Dredging.—In the *Engineering and Mining Journal* for September 11, W. H. Gardiner writes on estimates and extractions in gold dredging.

Zinc Metallurgy.—In the *Engineering and Mining Journal* for August 28, C. H. Fulton and J. B. Read describe a proposed system of roasting zinc sulphide in which the ore is dropped through a column of air in a vertical furnace.

Treatment of Copper Tailings.—In the *Engineering and Mining Journal* for September 4, Arthur Crowfoot and K. H. Donaldson describe the experimental plant at the Arizona Copper Co.'s mines used in treating old tailings. The treatment consists of regrinding, solution of oxidized copper in sulphuric acid, and flotation of the sulphide residue.

Copper Refining.—In *Chemical and Metallurgical Engineering* for August 18, Lawrence Addicks writes on the power problem in electrolytic copper refining.

Copper Smelting.—The *Engineering and Mining Journal* for September 11 contains an article by C. A. Grabill on the economics of blast-furnace charging in copper smelting. In the succeeding issue the same author writes on the selection of a slag and the apportioning of slag losses.

Electrostatic Dust-Settling. — At the September meeting of the Iron and Steel Institute, A. Hutchinson and E. Bury read a paper describing the plant used at the Skinningrove blast-furnaces for cleaning the furnace gases by the electrostatic process and for recovering potash.

Titanium White.—The *Chemical Trade Journal* for September 25 contains an article describing the manufacture of white pigment consisting of titanium oxide, as carried out by the Titan Company at Fredrikstad, Norway.

International Nickel.—The August *Bulletin* of the Canadian Institute of Mining and Metallurgy contains the second part of the paper on the mines and plant of the International Nickel Company. This part describes and illustrates the metallurgical plant.

Aluminium-Copper Alloys. — In *Chemical and Metallurgical Engineering* for August 25, R. J. Anderson commences a series of articles on aluminium-copper alloys.

Measurements of Folded Beds. — In *Economic Geology* for August, D. F. Hewett writes on calculations in connection with folded beds.

Thrust Faults.—In the *Journal of Geology* for August, T. T. Quirke discusses the mechanics of thrust faults.

Arctic Canada.—In the *Engineering and Mining Journal* for August 28, E. S. Moore describes the ore deposits north of Coppermine River.

Japanese Coal.—The *Colliery Guardian* for September 17 commences the publication of a report made for the Imperial University of Japan by Choso Iwasaki on the constitution of Japanese coal.

Yunnan.—The September number of the *Geographical Journal* contains a report of a lecture before the Royal Geographical Society by F. Kingdon Ward on travels through the north-western part of Yunnan, bordering on Tibet and Burma.

Normanby Goldfield, Queensland.—The *Queensland Government Mining Journal* for July contains a report by C. C. Morton, Government Geologist, on the Normanby goldfield, south of Bowen, which has recently shown signs of a revival.

Indooroopilly, Queensland. — The *Queensland Government Mining Journal* for July contains a report on the silver-lead mines at Indooroopilly, near Brisbane.

Lignite in Canada.—The *Bulletin* of the Canadian Institute of Mining and Metallurgy for September contains a paper on lignite deposits in Saskatchewan, by A. MacLean, assistant professor of geology in the University of Toronto.

Oil Shales in South Africa.—The *South African Journal of Industries* for August contains a paper by T. G. Trevor, Inspector of Mines, on current developments at the oil-shale deposits in the Wakkerstroom district, by the boundary between the Transvaal and Natal.

Mercury in Peru.—In the *Engineering and Mining Journal* for September 11, J. T. Singewald describes the mercury deposits at Huancavelica, Peru.

Water-Power in South Africa.—The *South African Journal of Industries* for August contains the first part of an article by F. E. Kanthack, on water-power resources in the Union of South Africa.

Oil-driven Locomotives.—The *Engineer* for September 10 publishes an article by E. C. Poultney on the performance of London and North Western oil-driven locomotives.

Albert Burch.—In the *Mining and Scientific Press* for August 28, T. A. Rickard publishes an interview with Albert Burch, giving particulars of his work in connection with Bunker Hill & Sullivan, Plymouth Consolidated, Goldfield Consolidated, Butte & Superior, and Mountain Copper.

RECENT PATENTS PUBLISHED.

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 1s. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.2., with a note of the number and year of the patent.*

243 of 1919 (149,366). H. J. WILSON, London. A portable roasting furnace for treating low-grade arsenical ores, to be used in association with an electric furnace for refining the arsenious acid.

3,754 of 1919 (149,707). F. A. FREETH and L. A. MUNRO, Northwich. Improvements in the standard methods of precipitating calcium and magnesium salts from brine, whereby the precipitate is not so flocculent but more easily settled.

9,088 of 1919 (149,384). J. A. BRANTLEY, Sand Springs, Oklahoma. An improved coal-mining machine.

10,338 of 1919 (150,020). J. R. SPEER, Trappe, Maryland. A hard and tough steel containing 0·5 to 1·25% carbon, 0·25 to 1·25% chromium, and 0·25 to 1·25% nickel.

12,494 of 1919 (149,769). J. MOREL, Grenoble, France. Method of preparing pure alumina from bauxite by first producing sulphate of alumina by the action of sulphurous acid and steam at high temperatures and then precipitating alumina from the solution by sodium thiosulphate.

12,698 of 1919 (149,783). J. J. HOOD, London. Manufacture of aluminium nitrate by reaction between aluminium sulphate and nitrate of lime or other nitrate.

12,699 of 1919 (149,453). J. J. HOOD, London. Forming alumina powder into granular condition for use in certain chemical operations by binding with aluminium nitrate, baking, and crushing, afterwards heating again to expel any remaining nitrate.

13,247 of 1919 (150,063). S. O. COWPER-COLES, London. Modification in the inventor's process for producing copper wire by electro-deposition.

15,109 of 1919 (150,113). W. MORLEY MARTIN, Redruth. In the inventor's glass-surface concentrating tables, described in patent 15,442 of 1914, arranging in such a way that the feed of the pulp is intermittent and alternating with water-flush, as in rag-frames.

15,296 of 1919 (150,116). O. HUTCHINS, Niagara. Improved treatment in electric furnace of aluminous material having for its object a highly crystalline aluminous abrasive, lower in titanium, iron, and silica than at present made.

17,395 of 1919 (150,494). W. MACK, Newtonfoot, Lanark. Improvements in the inventor's apparatus for signalling in mines.

22,565 of 1919 (149,851). JAMES FREW, Motherwell. Safety apparatus for ensuring the correct operation of signals in mines.

22,633 of 1919 (150,179). H. B. SHEPHERD, Derby. To prevent bending and breaking of pit props, placing over their ends caps containing a piston and cylinder which will let out fluid and shorten when a maximum pressure is reached.

25,688 of 1919 (149,552). H. O. HEDSTROM, Djursholm, Sweden. Improvements in the inventor's process for extracting radium, in which liquid sulphurous acid containing some liquid SO_3 is employed.

29,504 of 1919 (136,151). ELECTROLYTIC ZINC CO. OF AUSTRALASIA, Melbourne. In the electrolytic process for producing zinc, providing a protective coating of zinc on the aluminium cathodes above the solution level whereby the corroding action of acid sprays is eliminated.

32,672 of 1919 (137,519). FABRIQUES DE PRODUITS CHIMIQUES DE THANN ET DE MULHOUSE, Thann, Alsace. Improvements in the method of producing potassium sulphate by reaction between potassium chloride and sulphuric acid.

363 of 1920 (150,595). ALLEN ELECTROLYTIC CELL CORPORATION, Portland, Maine. Improved construction of cathodes and anodes of electrolytic cells, with the object of affording a maximum conducting surface for the passage of the current through the electrolyte.

654 of 1920 (150,597). S. O. COWPER-COLES, London. Making the zinc electrodes of primary batteries by electrolytic deposition.

1,013 of 1920 (138,600). INTERNATIONAL NICKEL CO., and R. C. STANLEY, New York. In extracting copper and nickel from copper-nickel matte, smelting the matte with bisulphate of soda until about 2 or 3% of copper remains in the nickel material, then roasting the latter and electrolytically refining. It is claimed that this process is cheaper than the usual practice in which the copper content of the matte is reduced to a small fraction of 1%, and that it saves more of the precious metals contained in the ores.

4,112 of 1920 (138,905). P. HABETS and A. FRANCE, Liége. An improved coal-washer.

NEW BOOKS, PAMPHLETS, Etc.

☞ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 723, Salisbury House, London Wall, E.C.2.

Technical Methods of Ore Analysis. By ALBERT H. LOW. Eighth Edition. Cloth, octavo, 390 pages. Price 19s. net. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

That another edition of this book has been published will be welcome news to many to whom it has proved useful, particularly because of the incorporation of the appendix of the earlier editions into the main text, an inconvenience which always exists when additions are made in the form of an appendix. Another appendix is, however, added. Some new methods are given, some of which will be extremely useful; for example, a very neat process for the determination of arsenic in crude sulphur is given. Barneveld & Leaver's method for the selective determination of the quantity of copper in the sulphide form and of that in the form of combined oxides, carbonates, silicates, and native or metallic copper in partly oxidized ores and in mill products should prove useful for the control on flotation mills treating sulphide ores, and also in lixiviation works using either acids or alkalies as the active solvent for the copper in oxidized and in silicate form. A good method is given for the determination of molybdenum in rich concentrates, namely, attacking with sodium peroxide and sodium carbonate and after reduction with zinc and subsequent oxidation with potassium permanganate. A method is given for the determination of phosphorus in tungsten ores, which is useful, but there is nothing novel in it. The method given for sulphur, namely, fusion with sodium carbonate and sodium peroxide, gives good results when the total sulphur is required to be estimated, the use of methyl orange to prevent an excess of hydrochloric acid, as used by Huntz & Weber in their modification of the Lunge process, giving certain results. Of the methods given for tungsten that called the Watts process does not seem to be particularly novel, but the cinchonine process is one which is decidedly good. An apparently quick method for the determination of uranium is given and should be useful, even in the presence of vanadium.

The book is one which is so well known, from previous additions, that it needs very little to be written about it to introduce its usefulness to most analysts, but for the benefit of those who are not well acquainted with it one would like to take this opportunity of pointing out the care the author has bestowed in making it so convenient to the busy man, for here he is not overwhelmed with many processes to select from when faced with a determination new to him. The author gives one or two methods, the ones found most useful to him, and then gives them *in detail* even to the shape of the flask or beaker. Here lies the great value of the book. How often has one found a good method wrecked by some important detail being left out of the description from which one is working? If this happens in laboratories where people have been trying new processes for years, how much more is it likely to lead to failure on the part of the student or beginner?

The book has become one of such utility that it should be in the library of every laboratory. It covers a wide field. Each element is given a chapter, and the arrangement in alphabetical order facilitates reference. These chapters are followed by one giving details of tests, etc., for fixing the value of water for steam purposes. A chapter on coal and coke follows, and then one on testing crude petroleum, and the book ends with the usual tables and data common to works of this character. ARTHUR J. CHAPMAN.

Mining Law of Nigeria. By GILBERT STONE. Price 15s. net. London: The Imperial Mineral Resources Bureau.

Manual for the Oil and Gas Industry under the Revenue Act of 1918. By RALPH ARNOLD, J. L. DARNELL, and others. Cloth, octavo, 200 pages. Price 13s. 6d. net. New York: John Wiley; London: Chapman & Hall, Ltd.

Lead. By DR. J. A. SMYTHE. Cloth, small octavo, 120 pages, illustrated. Price 2s. 6d. net. London: Sir Isaac Pitman & Co., Ltd.

Petrography and Chemistry of Refractory Materials. By DR. H. H. THOMAS, A. F. HALLIMOND, and E. G. RADLEY. Paper covers, octavo, 115 pages, with many illustrations. Price 5s. net. This is Vol. XIV of the Special Reports on the Mineral Resources of Great Britain, published by the Geological Survey.

The Mesozoic Rocks of Raasay and Skye. By DR. G. W. LEE and S. S. BUCKMAN. Paper boards, octavo, 94 pages, illustrated. Price 6s. net. This is one of the Scottish Geological Survey's publications. It contains information relating to the iron ore deposits which were described in the Magazine for June, 1918.

Determination of Molybdenum. By J. P. BONARDI and E. P. BARRETT. Technical Paper 230 issued by the United States Bureau of Mines.

Removal of the Lighter Hydrocarbons from Petroleum by Continuous Distillation. By J. M. WADSWORTH. Bulletin 163 issued by the United States Bureau of Mines.

Technical Writing. By T. A. RICKARD. Cloth, octavo, 180 pages. Price 8s. net. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

A Laboratory Outline of General Chemistry. By HERBERT N. MCCOY and ETHEL M. TERRY. Cloth, octavo, 160 pages, illustrated. Price 7s. 6d. net. New York and London: McGraw-Hill Book Company.

William Smith: His Maps and Memoirs. By THOMAS SHEPPARD, M.Sc., F.G.S. Cloth, octavo, 260 pages, illustrated. Price 7s. 6d. net. Hull: A. Brown & Sons, Savile Street and George Street.

Debentures: the Purposes they serve and how they are issued. By HERBERT W. JORDAN. Paper covers, octavo, 65 pages. Price 1s. 6d. net. London: Jordan & Sons, Ltd., 116, Chancery Lane, W.C.2.

Income Tax Guide, 1920. Paper covers, octavo, 36 pages. Price 1s. net. London: *The Financial Times*, 72, Coleman Street, E.C.2.

London School of Economics and Political Science (University of London); Calendar for the 26th Session 1920-1; Clare Market, Portugal Street, London, W.C.2.

Sir John Cass Technical Institute; Syllabus of Classes, 1920-1; Jewry Street, Aldgate, London, E.C.

COMPANY REPORTS

New Modderfontein.—Some record figures are contained in the annual report of this large Far East Rand gold-mining company, which is a member of the Central Mining-Rand Mines group. In the year ended June 30 last 968,500 tons of ore was milled (as against 920,500 tons in the previous year). The number of stamps in operation was 236, the average running time 278 days, and the crushing duty per stamp per 24 hours 14·2 tons. The total yield was 499,786 oz., the actual extraction being 97·9%. The value of the gold produced was £2,555,466, or 52s. 9d. per ton milled, an increase of 8s. 11d. per ton compared with the previous year's figure. Working costs amounted to £1,061,622, or 21s. 11d. per ton (against 20s. 2d.), the increase being attributed almost entirely to higher wages and the phthisis fund contribution. The acting manager, M. O. Tillard, mentions in his report that during only one month of the year was it possible to mill the full tonnage, the native labour supply again having been unsatisfactory. Given a full labour complement, however, the maximum tonnage could readily be obtained. The accounts for 1919-20 show a profit of £1,518,188, which is a record by as much as £416,130. Shareholders received in dividends £1,155,000, or 82½%, as compared with 62½% for 1918-19. The consulting engineer, H. Stuart Martin, in his report states that the gold premium gave the company an additional revenue and profit of 9s. 7d. per ton milled. Development operations were considerably increased, the total for the past year having been 17,449 ft. or 7,972 ft. more than in 1918-19. The payable reef disclosures at 643 inch-dwt. were 16 inch-dwt. higher, and the payable ore developed was estimated at 1,113,800 tons, averaging 10·1 dwt. per ton. The ore reserve at June 30 last amounted to 8,869,700 tons valued at 8·4 dwt. over 67 in. stoping width (inclusive of 389,700 tons valued at 7·1 dwt. consisting of shaft and boundary pillars). The testing of upper leaders continued, with, as a rule, favourable results. Although the grade of ore mined was again somewhat above the average value of the reserve, the consulting engineer asserts that this has in no way endangered the security of the mine. He points out that the actual results from mining have exceeded the value previously placed on the reserve, and current development has opened up ore of higher value than the average of the ore reserve. Eight additional stamps and some slime tanks are to be erected which will raise the capacity of the treatment plant by 10,000 tons a month. The cost, estimated at £30,000, will, it is stated, be quickly recovered provided sufficient native labour is procurable to produce the requisite tonnage.

Hampden Cloncurry Copper Mines.—This Australian company, which owns a group of mines on the Cloncurry field, Queensland, has acquired additional interests during the period covered by the latest report, namely, that for the half-year ended February 29 last. A lease, known as the Crown Lease, eight miles north of the Duchess mine, has been taken up, on which is exposed a very large leached gossan and limonite outcrops showing traces of copper, and a prospecting shaft has been sunk 64 ft. in leached lode formation containing occasional masses of high-grade copper glance. At this level heavy water was struck, and north and south drives started. The company has also taken an option on three leases known as the Kohinoor mines, two miles north of Dobbyn, where a small plant has been erected. During the half-year 37,161 tons of ore was raised from the company's mines, the individual outputs being as follow: Hampden 5,580 tons, Duchess 10,292 tons, Trekelano 10,600 tons, Salmon & Dingo 9,627 tons, Answer 669 tons, Pindora 262 tons, and smaller amounts from the MacGregor, Mount Macnamara, Mount Mascotte, and Magnet. The quantity smelted was 46,710 tons. The production was 3,359 tons blister copper, 1,454 oz. gold, and 23,136 oz. silver. The smelter ran continuously for 164⅓ days, or 3,944 hours. The ore reserves are estimated at 182,600 tons averaging 5½% copper, the figures for each mine being: Hampden 20,000 tons averaging 6% and 38,000 tons averaging 3%, Duchess 10,000 tons averaging 11%, MacGregor & Wallaroo 27,500 tons averaging 5%, Trekelano 35,000 tons averaging 10%, Answer 1,200 tons averaging 8%, Mascotte 900 tons averaging 14%, and Pindora 50,000 tons averaging 3%. The operations for the half-year resulted in a profit on working account of £74,470. A sum of £2,000 was received from dividends on shares held in other companies. There has been transferred to reserve for depreciation £11,546 and to reserve for plant expenditure £1,000. The surplus of liquid assets at February 29, 1920, was £164,036. The directors state that operations were affected by strikes, but add that the introduction of the Customs tariff has resulted in the company securing orders for a larger portion of the Australian requirement of copper wire, strand, etc., than was possible hitherto, and this increase of output has resulted in a diminution of the cost of manufacture.

Mount Morgan.—The report of this well-known Queensland gold-copper producer for the year ended May 30 last shows that 289,514 tons of ore was mined, 106,771 tons being classed as smelting ore, 179,670 tons as concentrating ore, and 3,073 tons as leaching ore. The quantity of ore raised was 294,485 tons, and in the concentration section 175,658 tons was treated for a yield of 67,836 tons of concentrates. There was smelted 178,055 tons, from which was produced 5,880 tons of fine copper and 80,578 oz. of gold. The roasting, leaching, and electrolytic investigations in the 10-ton unit were discontinued in May, the problematical savings being considered quite insufficient to justify the large capital outlay which would be involved in adopting this method of treatment. The ore reserves at May 30 last were estimated at 3,437,687 tons containing 2·59% copper and 6·11 dwt. gold per ton. The total revenue for the year was £1,013,760, and expenditure, including development and depreciation, £881,945, leaving a surplus on the 12 months' working of £131,815. The four dividends paid, amounting to 3s. per share, absorbed £150,000. The liquid assets, less current liabilities, at the date of the balance sheet amounted to £487,933.

King Island Scheelite.—Operations at this company's mines ceased on July 31 owing to the difficulty of selling tungsten concentrates. The company was formed in Melbourne in March, 1917, as a subsidiary of Broken Hill Block 14 Co., to work a scheelite property on the eastern side of King Island, Tasmania. The deposits are found at the contact between granite and slates which contain limestone bands and lenses, the limestone being altered to garnet and containing disseminated scheelite. The deposit is overlain by an overburden of clayey limestone 50 to 60 ft. thick. This is removed by steam shovel and the scheelite is worked by open-cut. The report for the half-year ended March 31 last shows that 15,823 tons of ore was mined averaging 0·67% WO_3 and that 120·9 tons of concentrate was produced averaging 69·6% WO_3. The percentage of recovery was 79·5. The concentrates were valued at £21,938, and the net profit was £5,911, out of which £5,000 was distributed as dividend, being 1s. per 10s. share on which 6s. has been paid up. Recent developments have been satisfactory and a new ore-body has been discovered. L. Venn Brown has been the manager since the beginning of operations.

Anantapur Gold Field.—The report for the year ended March 31 last states that the testing of old workings and outcrops at surface in different parts of the property (which is in the Madras Presidency) did not result in any discovery of importance. Sales of machinery and stores realized £2,381, and rents, dividends, etc., brought in £1,568, while expenses amounted to £924. At the close of the financial year the company held 30,218 ordinary and 827 preference shares of the North Anantapur Gold Mines and 535 preference shares of the Jibutil (Anantapur) Gold Mines. The report mentions that the lateral developments recently undertaken at the North Anantapur mine proved disappointing; reef formation was found with occasional shoots of quartz carrying small quantities of gold, but no payable ore ground was opened up.

Pekin Syndicate. — Coal production was commenced by this company in 1908, but at first considerable native competition and other difficulties were encountered. Subsequently, after prolonged negotiations with the Chinese authorities, an agreement was entered into with the Chinese Government whereby an Anglo-Chinese company was formed, known as the Fu Chung Corporation. This takes over all the coal produced by the Syndicate and the Chung Yuan Mining Company, a concern embodying all the native mining companies in the locality, and is the sole selling agent. The report of the Syndicate's consulting mining engineer, Arthur Hassam, for the year ended June 30, 1919, shows that the output from the Ja-mei-sen mines amounted to 550,547 tons as compared with 592,842 tons in the previous year. The most serious difficulty which has to be contended with at the mines continues to be the large amount of water, a further increase in quantity having taken place during the year under review. There was no serious inburst during the year, the increase having been of a general character from the existing feeders. Owing to the war the delivery of all plant and machinery, as well as ordinary materials and stores, was very greatly delayed, but the directors state that since the date of the consulting engineer's report (November, 1919) part of the new electrical power-plant has been installed, which will make it possible to deal with the large quantity of water more effectively. They attribute the reduced output, mentioned above, to abnormal conditions, and to the fire which occurred in one pit in January, 1919, as the result of an explosion. This caused the whole of the west-side workings to be closed down for the remaining months of the financial year, thereby considerably reducing the output during that period, and entailing heavy expense in recovery work. The Syndicate's sales to the Fu Chung Corporation amounted to 460,524 tons as against 471,993 tons in 1917-18. It is stated that the developments now in hand should, within the next few months, place the production of the collieries on a more satisfactory basis as regards both quality of output and cost. The Syndicate's accounts for the year ended June 30, 1919, show a profit and loss credit balance of £46,557, which has been carried forward.

Pena Copper Mines.—This company was formed in London in 1900 to acquire a pyrites mine in the south of Spain that had for some years previously been worked by a Belgian company. Small dividends were paid from 1903 to 1906. John F. Allan is consulting engineer, and E. Mackay Heriot is manager. The report for 1919 shows that the adverse conditions of the previous two years as regards freight and the marketing of pyrites have continued. The amount of ore raised during the year was 57,333 tons, as compared with 91,827 tons in 1918, and 160,121 tons in 1917. Of the ore raised, 51,747 tons was added to the leaching heaps and 5,586 tons was stocked for export. The output of fine copper contained in precipitate produced at the leaching heaps was 529 tons, as compared with 554 tons and 587 tons. The shipments during the year were 33,308 tons of leached pyrites and 14,589 tons of non-cupreous pyrites, making a total of 47,897 tons, as compared with 72,023 tons and 145,120 tons in 1918 and 1919 respectively. No cupreous ore was shipped during the year; in 1918, the shipments were 5,458 tons, and in 1917, 24,460 tons. After all allowances had been made for depreciation, taxes, and interest, the year's profit was £350. This, with the balance from last year, £63,781, was carried forward.

The Mining Magazine

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PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LIMITED AND REDUCED, AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938*. Telegraphic Address: *Oligoclase*. Codes: *McNeill*, both Editions.

BRANCH OFFICES: 420, Market Street, San Francisco. 300, Fisher Bdg., Chicago. 2,222, Equitable Building, New York.

SUBSCRIPTION: 16s. per annum (Single Copy 1s. 6d.) including postage to any part of the World.

Vol. XXIII. No. 5. LONDON, NOVEMBER, 1920. PRICE 1s. 6d.

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EDITORIAL

THE president-elect of the Institution of Mining and Metallurgy is Mr. F. W. Harbord. It is hardly necessary to introduce Mr. Harbord to our readers as a leading British authority on the metallurgy of steel. He does not confine his attention to ferrous metals, for he is also well known for his work in connection with lead and zinc.

IT is not generally known that the Société des Ingenieurs Civils of France has a British section, the address of which is 45, Great Marlborough Street, London, W.1. The meetings are held at the hall of the Royal Society of Arts. On the 9th inst. the president of the Society read a paper on the destruction of the mining district of Northern France during the war and the work of reconstruction. We may remind readers that the Society takes more cognizance of mining operations than our own Institution of Civil Engineers.

THE coal strike has once more drawn attention to the logical way of avoiding the consequent difficulties, that is to say, the more economical method of using the coal after it is mined. Sir Robert Hadfield has written on this subject to the daily press, pointing out that the Government electricity commission should be so widened as to include consideration of all the problems of light, heat, and power. Every engineer knows of the waste of fuel and other sources of energy, but his first concern is his own requirements and opportunities, and he is seldom able to adopt an altruistic policy. He would welcome a Government committee or similar body that would regulate relations between consumers and between producers of power, and also between both, without attempting to put production under Government management.

PRINTERS suffer from phthisis as well as miners, but it is not usually supposed that the ultimate causes are the same. The statement made by Dr. Halford Ross that fine silica does the damage in the lungs of the printers is therefore greeted by an expression of surprise if not of incredulity. He says that the fine silica is introduced into the atmosphere by the attrition of the iron frames in which the type is locked, this attrition loosening the foundry sand that adheres to the frames. At the same time the vegetable material used in making a stereotype cast of the type frays, and the fine fibres float in the air with equally fine silica adhering to them. This is quite a credible statement, but unfortunately other physicians say that the lungs of printers who have died of phthisis show no symptoms of silicosis as known in the lungs of miners. Further arguments are awaited.

SOME months ago rumours were circulated in Cornwall that a chlorine process, invented by Mr. Jerome J. Collins, was to be tried on Cornish tin ores, the object being to secure a higher recovery than is possible by wet concentration methods. The rumours were a little previous, but they will be substantiated before long. In the meantime Mr. Collins has written an outline description of the process, and this is printed elsewhere in this issue. Dry chlorine is used in the Goldschmidt process for stripping tin from scrap tin-plate, and Mr. Collins uses it in refining impure tin. Whether it can be applied commercially to tin ores can only be ascertained by experience. Many metallurgists look to chemistry for the missing tin process, analogous to cyanidation as applied to gold and silver ores, and to flotation as applied to sulphides, so that Mr. Collins's experiments with this method will be watched with uncommon interest.

LAST month we drew attention to the looseness of terminology employed in stating the contents of tin ores and the recoveries obtained in dressing. This month a correspondent draws attention to the fact that the looseness is not confined to the methods of expressing ideas, but is found also in the ideas themselves. In particular he complains that the efficiency of a concentrating operation is too often judged solely by the percentage of recovery, no account being taken of the nature of the material under treatment. This point has been more than once raised in these pages. On one occasion it was necessary to explain to a critic, who alleged that the practice at Cornwall Tailings was poor because the recovery was only 35%, that the material had already been treated by previous owners, and that under the circumstances the recovery from the tailings was really quite good. On another occasion a reader of the MAGAZINE had drawn attention to a supposed superiority of the dressing practice at one of the South African tin mines, where over 80% of the contents of the ore was being obtained, and that without a slime plant. This reader had quite forgotten that the mine was on the outcrop and that there was a liberal proportion of coarse cassiterite in the ore, whereas the Cornish mines are at present treating much finer material. This confusion of ideas relating to efficiencies of recovery point once more to the fact that statistics are of little value if unaccompanied by explanations of the conditions.

The Finsbury Technical College.

A few months ago we gave a biographical notice of Professor John Perry, and recorded the exceptionally brilliant work which he did, first at the Finsbury Technical College and afterward at the Royal College of Science. His methods of teaching science as applied to engineering had an enormous influence on the system of technical education, and the scheme he introduced at Finsbury has been copied the world over. It is disconcerting to find, therefore, that the Board of Education contemplates closing the College, owing to the disinclination of the Board to supply the necessary funds from the public purse. The College has no mining department, so that the average reader of the MAGAZINE probably knows little of its functions. On the other hand, not a few of the London metallurgists received their training there, and they speak in no uncertain voice of its chemical department and the excellent opportunities provided for practical instruction and research. We desire to associate ourselves with our metallurgical friends in connection with the petition they are addressing to the Board of Education and the City & Guilds of London Institute, asking that the College shall not suffer extinction.

It will probably be remembered that the City & Guilds of London Institute was formed in 1878 for the furtherance of the teaching of science as applied in the productive and technical industries. As the name implies, the founders were the Corporation of the City of London and a number of the City Guilds, or "Livery Companies," the ancient institutions formed to protect the interests of each particular trade. A number of educational centres were created by this Institute, of which the Finsbury Technical College and the City & Guilds Engineering College were the chief. The latter was established at South Kensington, and is now part of the Imperial College of Science and Technology, having for its near neighbour the Royal School of Mines. Finsbury College is near the City, and only a few minutes' walk northward from London Wall. The courses of instruction provided by its curriculum are rather practical than of the University type, and on this basis the College has turned out great numbers of sound engineers, electricians, and chemists. It has always been fortunate in having professors of distinction. Besides John Perry, the eminent members of its staff have included Silvanus Thompson, Raphael Meldola, and H. E. Armstrong, of whom the last-named alone is still with us, though he left the College many years ago. Silvanus Thompson was principal for a quarter of a century or more, and, though his qualifications as a scientist and a lecturer were such as to bring him innumerable invitations to transfer his services elsewhere, he remained faithful to the College until his death in 1916. The present position of the College is said to be bad financially and, as we have mentioned, the Board of Education does not see its way to grant the necessary subsidy. In the absence of this public support, surely the London Corporation and Guilds are not unwilling to shoulder the responsibility for the work which they began.

Membership of the Institution.

The Institution of Mining and Metallurgy has taken an important step in advancing its professional status by altering its by-laws in such a way that scientific education shall in future constitute a substantial share in the qualifications for membership. The proposals of the Council to this effect were discussed at a special general meeting of the Institution held on October 21. Perhaps "discussed" is not the right word, for everyone was in agreement with the Council, and the remarks of the President, Mr. Frank Merricks, and of Messrs. S. J. Speak, Hugh K. Picard, and E. T. McCarthy were received with ready acclamation. The new by-law relating to admission to membership, after providing that the applicant shall have been in full charge for at least five years of important mining or metallurgical operations, or shall have for a similar period been in practice as a consulting mining engineer or metallurgist, goes on to stipulate that the applicant, if born after December 31, 1894, shall have passed through a regular course of study in pure or applied science of at least three years' duration. A candidate for admission as an associate need not have had this scientific education, but the years spent in such training count for qualification. The new by-law says that a candidate shall have been engaged in mining or metallurgical pursuits for a period of not less than six years; if he has graduated from the Royal School of Mines, or other mining school of the same standard, his four years thereat shall rank as years devoted to mining and metallurgical pursuits; if he has graduated from any other technical college he shall be credited with three years. It will be seen on examination of these new by-laws that in the future full membership will only be open to those who have had a college education, and that the so-called practical man will never reach a higher stage than associateship.

At the same meeting a resolution to raise the entrance fees and yearly subscription rates was placed before members, and was adopted unanimously without comment. When the Institution was inaugurated twenty-eight years ago, the yearly subscription was £2. 2s. for members and £1. 11s. 6d. for associates. In 1908 it was found necessary to raise these dues to £3. 3s. and £2. 2s. for all members and associates elected subsequently, the yearly subscriptions for those elected up to that time remaining unaltered. Since that time the business, and, in consequence, the expenses of the Institution have continued to grow, and of course the last two years has seen a great increase in costs, here as elsewhere. About three years ago a further increase in the dues was mooted, but, owing to so many members being away on war work, the matter was left to individual action. The members and associates elected before 1908 were asked to forgo their rights and voluntarily pay at the same rate as those elected subsequently. A large majority of these members and associates agreed to the proposal and the finances of the Institution benefited accordingly. This increase in the revenue did not, however, suffice for long to meet the growing demands on the Institution's funds, so that the Council recently determined to propose a further advance to five guineas for a member and three for an associate, and to ask members and associates to agree to a modification of the by-laws accordingly. It will be noted that the Institution has taken what appears to us a much more dignified step in connection with its financial affairs than the American Institute of Mining and Metallurgical Engineers. In the latter case the council have resorted to the device of increasing the membership instead of raising the rates of subscription. They have indeed been conducting a strenuous campaign to this end, and have "beaten the bushes" and gone into the "highways and hedges" for new members. Thus the qualifications of membership are being eased, while the Institution is making the rules for admission more stringent. Perhaps this diversity of method merely follows a diversity of conditions, and it is therefore not competent for us to compare the variation of policies. All that can be said is that the Institution has taken the steps unanimously approved by its constituents.

The Origin of Ore Deposits.

The paper read at the October meeting of the Institution of Mining and Metallurgy was by Dr. J. Morrow Campbell and dealt with a new theory of cosmogony and the origin of ore deposits. A lengthy abstract is given in the Mining Digest, but the paper ought to be read in full, for to the inquiring mind it often happens that some item appearing to be unimportant to the abstractor may supply the missing guide in an argument. The author's theory is an amplification or rather a development of ideas expressed in papers that have been published in the MAGAZINE. The author found evidence in the field and in the petrographical laboratory against the theory of pneumatolysis as applied to the origin of tin and tungsten deposits, and in favour of their deposition from magmatic waters. He proceeded then to examine the usually accepted theory of magmatic waters, and found a stumbling-block in the way of its acceptance in the fact that above a certain temperature known as the critical point water cannot exist as a liquid, however great the pressure. It became evident to him that under magmatic conditions the elements of water must have been absorbed into the molten mass, and subsequently have been existent in the residual liquors after crystallization of the igneous rocks, in some different state or condition from what is known on the surface of the earth as water. He has brought forward in the present paper the theory that the elements of water joined the silicates as the radical hydroxyl, and that the water of the residual liquors existed in combination with silica as silicic acid. As far as the first part of the theory is concerned, we confess our inability to judge one way or the other, but the second part is distinctly helpful. We know little of silicic acid as such, but there is no inherent reason why it should not exist under certain conditions of temperature and pressure. Certainly the formation of silicious lodes and veins, either barren or carrying metallic minerals, would be agreeably explained according to this theory, and we accordingly recommend readers to follow Dr. Morrow Campbell's detailed arguments and illustrations.

It seems to us that much more has yet to be done in connection with the theory of ore deposits by applying known physical laws which at present are apparently neglected by geologists. Mr. W. H. Goodchild and Dr. Morrow Campbell, both of them chemists and physicists as well as geologists, may be depended on to follow up the researches on these lines, and study the physical conditions following on high temperatures and pressures. There are a number of lines of research open to a geologist. For instance, one may be based on the theories and facts of solutions, and another on the effect of re-heating and pressure on the phenomena of paragenesis. As regards the first of these, it is desirable that we should know what a magma really is; whether it is merely a mixed melt of various substances, or whether it is a solution of one or more substances in another. It is known in the chemical laboratory that when one substance dissolves in another the total volume is not usually the sum of the volumes of the constituents. A familiar instance of this principle is that presented by mixtures of alcohol and water, the specific gravity of the mixture being greater than that of either constituent, with a corresponding shrinkage of volume. Applying this idea to magmas, it becomes obvious that the first portions to crystallize out need not necessarily fall to the bottom, and that the lighter portions, in crystallizing, may cause an increase in the total volume, thus giving rise to the formation of a granite boss. This theory of solution may also partly explain why the supposed molten mass of the interior of the earth is of higher specific gravity than the superficial crust.

The second point we have raised, namely, the effect of high temperatures and pressures on the crystalline formation of rocks and lodes, might be investigated with advantage from the point of view of the metallographist. The latter received, in the days of Sorby, the benefits of microscopical petrographic methods as applied to the examination of metal structure, and it is highly probable that the boon might now be transferred in the opposite direction, by the metallographist helping the petrographer. At the present time conclusions with regard to the paragenesis of minerals are based entirely on the interpretation of conditions as governed by atmospheric temperatures and pressures. A metallographist, however, will show that with heat treatment and pressure the crystalline disposition may be rearranged, and that crystals may be forming and being eaten into simultaneously. Moreover, it is not necessary that a solution or mixture should be liquid for crystallization to take place. It was for this reason that we drew attention last month to Professor Carpenter's paper read before a recent meeting of the Institute of Metals, and we may repeat here our recommendation that geologists and metallurgists should collaborate in this matter. We know to some extent the nature of metamorphic action on rocks and lodes; is it not possible that the action may be much more far-reaching than is at present suspected, and that what are apparently primary deposits from magmatic waters may have passed through some stage of metamorphic heat-treatment? The suggestions we make here are baldly expressed, and are more in the nature of arm-chair philosophy than those that are based on field-work. Unfortunately it is not likely that any of these speculations in cosmogony will ever be checked by direct observation; nevertheless inductive logic may do a great deal toward solving these mysterious problems of economic geology.

The Minerals of Yunnan.

In this issue we print the first half of an article on the mineral resources of Yunnan, the province in the south-west of China, bordering on Burma and French Indo-China. This has been written by Dr. J. Coggin Brown, a member of the Indian Geological Survey, who probably has as intimate a knowledge of that part of the world as anybody. The subject is not a new one, for it has been discussed many times by French, English, and American engineers and financiers, and several attempts have been made to secure European and American participation in the development of the mineral deposits. It is only comparatively recently that American mining men have turned their attention to this part of China. At the present time a party of American geologists, headed by Mr. H. Foster Bain, are making examinations, chiefly with a view of finding deposits similar to that at Bawdwin over the Burma border, but also with an eye for tin ore. Under these circumstances Dr. Coggin Brown's description of the country and its minerals will be of considerable timely interest. His general impression of the country is that there are no more surface deposits to be discovered. China is not a virgin mineral region as was North America when the white man first went there. The Chinese have worked gold, silver, copper, tin, lead, and antimony from time immemorial, and the simple ores and the outcrops are well nigh exhausted. Evidence points to the fact that the outputs of all these metals are much lower now than formerly. In fact the local methods of mining and metallurgy cannot carry on much longer in connection with such metals as silver, copper, and lead. It is highly probable, however, that complex ores exist at greater depth, and that large bodies of low-grade ore may be found. Some of the prospecting now being done is based on experience in Burma and also in the Altai region, but so far as is known no definite proof has as yet been obtained in support of these anticipations and suppositions.

The history of the efforts of outsiders to conduct mining work in Yunnan is similar to that in connection with other parts of China. From the beginning there has been the greatest difficulty in establishing commercial relations. Permission and facilities to trade were granted unwillingly by the authorities, and on several occasions were secured only by force of arms. The Chinese governors knew all the tricks of both Eastern and Western diplomacy; they knew how to put the European nations at variance with each other over a concession, and, after granting one, introduced so many complications as to render it virtually a dead letter. The spheres of influence on the part of foreign countries have established themselves on what may be called natural lines. The English exerted their influence on the southern and eastern coasts at or near the mouths of navigable rivers. Russia and Japan have exercised pressure in the north. France, having first obtained control of the Empire of Anam, made its influence felt in the neighbouring Chinese provinces of Yunnan and Kwang-Si. More recently Germany and the United States entered the competitive race. The elimination of Germany has removed a cause of much friction, and the collapse of Russia has also caused relief. At one time it was believed that serious trouble would arise between the United States and Japan on account of the latter's insistent demands on China. It seems, however, that there are influences tending toward mutual toleration between Japan and the United States. For instance, the *Far Eastern Review*, an American periodical published at Shanghai, is now friendly to the Japanese.

As regards the development of Yunnan, this has been almost entirely in the hands of the French, and at present the only railway connecting Yunnan with the outside world comes down from Yunnan Fu to Hanoi and Haiphong in Tonking, the northernmost state of French Indo-China. Since the whole of Burma was included within the Indian Empire, British mining operations have been established near the Yunnan frontier, and much of the old-established Burmo-Chinese trading is now in British hands. Probably it will not be long before the railway from Mandalay to Lashio is continued to Yunnan-Fu. Before the railway was built by the French, the chief communication with Yunnan was by way of the Red River, and about forty years ago attention was drawn to the mineral resources of the country by consignments of copper and tin sent down this river by French travellers. In 1894 the Lyons Chamber of Commerce sent expeditions to Yunnan for the purpose of investigating trade opportunities, and one of the results was the issue of reports on the minerals of Yunnan and adjoining provinces in the north, prepared by M. Duclos. Another important event took place in 1898, when the Yunnan Syndicate was formed by English and French capitalists conjointly for the purpose of seeking mining concessions. One of the early expeditions sent out by this syndicate was headed by Mr. Robert M. Raymond, who afterward became so well known for his work in Mexico. Mr. Raymond was not impressed by the supposed opportunities presented for working old copper mines, nor was he enamoured of the complicated methods of Chinese official control. The subsequent history of the syndicate was one of consistent disappointments, largely arising from the unfriendliness of the various branches of the Government and of the people themselves.

In earlier issues of the MAGAZINE, we have published a number of informative articles on mining operations and possibilities in the provinces adjoining Yunnan, and it is convenient to give references to these as they may be read to advantage in association with Dr. Coggin Brown's article on Yunnan. Mr. H. W. L. Way wrote in the issue of July, 1916, on the mineral resources of Sze-Chuan, and in November of that year Mr. J. A. T. Robertson gave an account of his journey through the same region. In the issue of September, 1915, Mr. Gilmour E. Brown told of the tin deposits in Hunan, and in February, 1917, Messrs. A. S. Wheler and S. Y. Li described zinc-lead mines in the same province. This list of recent literature would not be complete without reference to Mr. W. F. Collins's paper on the tin mines of Yunnan, read before the Institution of Mining and Metallurgy in December, 1909, and quoted at some length in the MAGAZINE for January, 1910. The impression received by reading these articles, and from current news continually arriving, is that more facilities are now being given to foreigners for the examination and exploitation of mineral deposits. Thus it may be hoped that Dr. Coggin Brown's communication will prove to be of practical value to the mining profession.

REVIEW OF MINING

Introductory.—We have been in the grip of the coal strike during the past month, and business of all kinds has been greatly restricted in consequence. The United States presidential election has cleared the political position there, and with a President, Senate, and House of Representatives all on the republican side, it is probable that the country's policy will be clearly defined. News from Broken Hill is much more encouraging; the men have accepted Mr. Justice Edmunds' award, and work will probably be started again before the end of this month. In the metal market copper, tin, and zinc have been weak, and silver has been erratic, but the price of gold has been going up again, on the renewed weakness of American exchange.

Transvaal.—The labour figures continue to show a decrease, which is not entirely explained by the seasonal migration of the natives. The fact is that mining is gradually losing its commanding position as a factor in industry, and none of the steps taken during the last few years with the object of meeting the requirements of the mines is effective for long. Now that the chairman of the Transvaal Chamber of Mines is an "outsider," it is probable that the question of labour supply, as between the Government and the Chamber, will be treated from a standpoint resembling that of the disposal of gold-mining lands, especially seeing that these two problems have an important point in common.

Another Phthisis Committee has been appointed by the Union Government for the purpose of considering the necessity for further steps to be taken for the prevention of the disease, and also to discuss insurance problems, and the extension of the present law to other mines and trades.

The south shaft at the New State Areas property reached the reef at a depth of 3,676 ft. Twelve sections taken over the whole of the shaft gave an average assay-value of 89·8 dwt. over 18·9 in. This is a result in appropriate keeping with the property's nickname, "The Jewel Box."

Recent developments at Geduld have given excellent results. In the east drive on the seventh level from No. 3 incline, toward the site of the new shaft, and in rises and winzes from this level, 64% of the 2,820 ft. sampled has proved payable, the average assay-value being 17·6 dwt. over a stoping width of 66 in. The end of this rich shoot is not yet in sight.

Another serious fall of ground has taken place at Village Main Reef, with the result that the mine is to be finally closed. The fall extended for 600 ft. on the 15th level, and it cut off access to the leased area where most of the work has been done lately. Though regular mining is suspended, it is likely that some of the richer remaining ore will be removed in order to cover the cost of withdrawal and closing down.

The directors of Modderfontein East are taking steps to secure the subscription of sufficient funds to provide a milling plant, and a meeting of shareholders is called for December, at which powers will be sought to issue the necessary shares without delay. There are 183,706 shares available for this purpose, but it is not yet decided as to the price of issue. It will be remembered that the company is at present using the Kleinfontein company's Apex plant, and is sending the ore seven miles by rail. It is believed that the company is intending to buy the plant of the Simmer Deep and Jupiter companies, which have recently suspended operations.

The African Platinum Mines, Ltd., is the name of a company formed to operate in the Engcobo district, where platinum has been found in iron ore. As there is considerable doubt as to the nature of the occurrence, the company is undertaking extensive research work in connection with the ore and its constituents.

Elsewhere in this issue details are given of the oil-shale deposits at Wakkerstroom. Cable reports announce favourable results from bulk tests in Scotland, and in all probability the Government will build a spur line to the properties.

Rhodesia.—The British South Africa Co. has not yet received the judgment with regard to reimbursement by the Government of the expenditure incurred by the company in administrative work. The delay is due solely to the action of the Government in seeking new evidence. Under the auspices of the company the Rhodesia Railways and Rhodesia Trust are about to raise new capital to the extent of £1,500,000 in the shape of notes, for the purpose of improving the rail-bed and providing additional rolling stock.

It is announced that in all probability the Cam and Motor Company will require further funds for the completion of the development and reorganization scheme, in addition to those supplied by the reconstruction last year. The money is to be provided by Sir Abe Bailey or one of his companies, and shareholders will not be called upon to contribute again.

Kenya Territory.—The progress of the Magadi Soda enterprise is still blocked by many adverse conditions. It is difficult to get delivery of necessary plant, and the works near Manchester are still in the hands of the Ministry of Munitions. The caustic soda plant at Calcutta is steadily producing, but is not yet working to full capacity.

Nigeria.—Owing to labour shortage and railway congestion, the output of tin concentrate at the various properties of the Rayfield company has been seriously restricted recently. During 1919 the output was 623 tons, as compared with 678 tons during 1918, while for the first eight months of the current year the figure was only 285 tons. Mr. John M. Iles, the general manager, reports that, unless something unexpected happens, the position will return to normal before the end of the year. Owing to the temporarily adverse position, the balance of profit for the year 1919, amounting to £26,407, is being kept in hand. The developments have been good of late, exceptionally rich deposits having been found on the Shen River, Central Shen, and Old Shen properties. The outlook for the future is highly satisfactory from this point of view.

The Ropp Tin Company reports an output of 168 tons of tin concentrate for October. This is by far the largest monthly output ever recorded by a Nigerian company.

The offer of Levers to purchase the share control of the African and Eastern Trade Corporation has been accepted by the shareholders, though considerable opposition had arisen in various quarters.

With the object of economizing in administration and using labour to the best advantage, it has been decided to amalgamate the Jemaa Exploration, the Keffi Tin, and the Toro Tin companies. The new company is called the Keffi Consolidated.

Australia.—News is to hand to the effect that the Broken Hill mines are to be re-started, as the men have agreed to accept the terms of Mr. Justice Edmunds' award.

The gold producers in Australia have been reaping the advantage of the premium by selling their produce to the East. More recently negotiations have been concluded whereby gold is to be sold in New York, the amount contracted for being 164,700 oz. at the price of 96s. 8d. per ounce.

The Mount Boppy gold mine in New South Wales was the victim of drought for three years until July last. Eighteen months ago the financial position was rendered so serious by the enforced idleness that the company was reconstructed, funds to the extent of £22,000 being thereby provided. From July to December, 1919, the milling plant ran for less than half the time, and for the next six months work was intermittent. In July of this year conditions improved, and in September the outlook became normal once more. During the period of inaction very little development was done. The reserve is reported at 165,714 tons. During the year ended June 30 last, the mill ran 109 days, and treated 17,464 tons for a yield of gold selling for £25,628. The working cost was £38,849.

The Queensland Government announces that it has decided to exercise its option for the purchase of the Yampi Sound iron ore deposits. These deposits were described in last month's issue of the MAGAZINE.

The Imperial Mineral Resources Bureau has issued a statement relating to a cobalt deposit 19 miles south of Selwyn, in the Cloncurry district of Queensland. The chief ore-mineral is cobaltite, averaging 33% of cobalt and 40% of arsenic. A considerable amount of development has been done on the lode, and ore has been raised to the surface, averaging 10 to 25% cobalt. It is not stated whether this ore is being marketed or not; probably an outlet is being sought.

India.—The Nundydroog company is to be reconstructed, and new capital raised, in order that development shall be continued at depth. The present equipment is only capable of dealing with operations to 4,000 ft. in depth on the incline. In order to provide facilities for deeper working, a circular shaft was commenced some time ago, and it still requires to be finished. Mr. C. H. Richards, the superintendent, mentions the necessity of sinking two other vertical shafts. Before these three shafts come into operation, development below 4,000 ft. will be done by means of main winzes. The directors ask for £170,000, and the proposal is to reconstruct the company with a liability of 6s. per 10s. share. The developments in depth are sufficiently good to warrant the expectation that the mine will continue to yield profitable ore. The Ooregum, to the south, contains profitable ore at a considerably greater depth, and recently the Balaghat, to the north, has developed rich ore in depth near the Nundydroog boundary.

The yearly report of the North Anantapur gold mine shows that the directors and managers have little hope of further discoveries of payable ore, and the operations will not be continued much longer. As regards other properties, the first copper prospect examined has proved disappointing, but another, also in Chota Nagpur, is affording much better hopes of success.

Siam.—The dredging property of the Renong Dredging Company on the western coast of Siam will be exhausted in two or three years. No. 1 dredge has sufficient ground to keep it employed for two years and No. 3 for about four years. No. 2 dredge has already been transferred to the new property at Rasa, in Selangor, and will commence operations there by the end of the current year. Nos. 1 and 3 will follow it when their work is completed at Renong. Some particulars of the Rasa property were given in the February issue.

Cornwall.—The position of the Cornish tin mines gives rise to much anxiety. The coal strike has come at an inopportune moment, and will probably be the proverbial last straw that breaks the camel's back. It will hardly be possible to continue mining at Dolcoath, and the future of the mine depends on the plan for lateral exploration, which has been held in abeyance by the uncertainty of the position. Grenville is cleaning up and will be closed shortly. Tincroft is in a critical position, but it may be saved by the courageous action of the men, who are willing to forgo some of their money so that it may be used for the purposes of the mine. The stream of emigration from Cornwall is a feature of the times, and the certainty of employment in the United States and Ontario will continue to offer the inducement.

It will be noticed, in the statistics pages, that East Pool put in appearance at the Tin Ticketings on October 18. The reason for this was that the private contract had expired the fortnight before, and that the smelting firm was disinclined to take any more supplies pending the settlement of the coal strike. The company has since arranged another contract, this time with the Penpoll Tin Smelting Co., and is delivering to the smelter situated on one of the arms of Falmouth harbour.

In a Letter to the Editor, printed on page 296, Mr. E. Homersham comments on our Camborne correspondent's reference, in the October issue, to the acquirement of Wheal Busy mine by the Killifreth company. Our correspondent, in urging that the capitalization of the company was too high, called the Wheal Busy a waterlogged mine. Mr. Homersham draws attention to the fact that there are large bodies of payable arsenical tin ore above adit. Mr. Josiah Paull, in making a report on the mine to the company, made the same statement, remarking that satisfactory profits could be earned from this ore. It is known that ore richer in arsenic is in place below water-level. As there are pumps available for dealing with the water, access to the richer ore should be gained in due course. Our correspondent did not make mention of the whole of the above facts, so that probably his criticism created a wrong impression as to the exact position.

The Calloose company has been in court on two separate occasions during the past month. In the first case, certain shareholders petitioned successfully for the removal of their names from the register. The effect of this judgment of the court is that these shareholders will become creditors in case the company is wound up. In the second case, the Naraguta (Nigeria) Tin Mines, Ltd., petitioned for the compulsory winding up of the company. The Naraguta company had comparatively recently undertaken to supply additional capital for the development of the properties, but had since come to the conclusion that the properties are valueless. Counsel for Mr. A. F. Calvert, the original vendor, offered on his client's behalf to present the company with additional properties and to raise sufficient working capital. The petition was accordingly adjourned, in order that shareholders should have time to consider this proposal. They will probably now have sufficient experience in these matters to induce them to examine the reports on mining properties a little more closely than they did when the prospectus was published.

Devon.—Last month it was recorded that the property of the China Clay Corporation at Redlake and Ivybridge was being sold by auction by order of the Court. It is now reported that the chairman of the company, Mr. Mallaby Deeley, purchased the property. Hopes are expressed locally that the company will not be resuscitated until a china-clay engineer has reported on the real value of the deposits.

English Oil-Shales.—The directors of English Oilfields, Ltd., which is developing the oil-shale deposits in west Norfolk, have issued a lengthy report by the geologist and chemists as to the progress of the work. It is stated that the shale is to be attacked by open-cut and steam shovels instead of by underground mining, and that Mr. John Black has devised a retort suited for the distilling operation. We still wait, however, for a report by an oil engineer of recognized standing with regard to the tout-ensemble of the scheme.

Canada.—Reports are to hand of the discovery of a strong oil flow at Fort Norman, near Great Bear Lake, by engineers on the staff of the Imperial Oil Company. As the well is a thousand miles from anywhere and is situated near the Arctic Circle, it is clear that transport is a serious factor in the case.

United States.—The Alaska Treadwell group of companies have options on properties situated on a tributary of the Kuskokwim, a river which flows into the Bering Sea at a point south of the mouth of the Yukon. The ore is valuable chiefly for its gold, averaging as much as $30 per ton, but it also carries a few ounces of silver, and some of it contains copper.

The Anaconda company has recently become a lead producer, one of the old blast-furnaces having been altered so as to treat the leady residues from the electrolytic zinc plant.

Mexico.—Further cables from the Esperanza with regard to the discoveries on No. 5 level show that though the ore has been found again, the assays are not of the spectacular nature of those recorded last month. The results are, however, encouraging, particularly in a rise, where the ore averages 4 oz. gold and 196 oz. silver per ton over a width of 19 inches. At the adjoining Mexico property, a rich strike is recorded on the 11th level in the Nolan claim. Here the ore for 120 ft. averages 25 oz. gold and 600 oz. silver per ton over a width of 12 to 18 inches.

Colombia.—The capital of the Colombian Mining & Exploration Company has been increased to £1,000,000 by the creation of 450,000 new shares of £1 each, and the development of the oil and gold properties is to be actively prosecuted. The subscribers of the new capital are taking control. Mr. John Morgan, who was well known at Kalgoorlie, has been appointed as consulting engineer. His services will be of great value in connection with the treatment of the troublesome ore at Marmato. The oil properties under the control of the company are now on offer to one of the big oil groups.

Siberia.—The Lena Goldfields, Ltd., has bought a 45% interest in the Altai Mines, Ltd., a local company owning lead, zinc, and copper deposits in the Altai district. The total ore reserve, consisting chiefly of lead and zinc sulphides, with precious metal contents, at three of the properties, the Zyrianovsk, Byelousovsk, and Bereosovsk, is estimated at 3,000,000 tons. At the Lazoursky mine, large bodies of ore averaging 5% copper over an average width of 5 ft. have been indicated by diamond-drilling. Messrs. A. Gernet and Norman C. Stines have reported on these properties.

The Orsk Goldfields, Ltd., has issued a circular giving an account of the events which led up to the Bolshevik attack on the property, and of the experiences of the manager, Mr. G. S. Dyer. It appears that, on his way from Nicolaievsk to the dredging ground, Mr. Dyer was caught by the "Reds," who took possession of the property, and nationalized it, appointing a committee of three to act as managers over Mr. Dyer and the staff. This state of things continued for some months, but no proper mining could be done, so Mr. Dyer accordingly exerted every endeavour to withdraw the staff and get away. Eventually by a clever ruse he got permission to go to the Chinese Consulate at Nicolaievsk. He there obtained the assistance of Chinese gunboats, and proceeded to the mine by way of the Amur river. He was successful in rescuing the staff, but was not able to arrange for military protection of the property. The Bolsheviks in exasperation thereupon destroyed the whole of the company's property, as was recorded in July last.

The Revenue authorities have withdrawn their claim for a big sum on account of excess profits duty from the Russo-Asiatic Corporation, so that liquidation can now proceed. This victory of business over bureaucracy is largely due to the persistence and sagacity of Mr. J. P. B. Webster, the London manager and secretary of the corporation.

Spain.—The position at Rio Tinto continues much the same. The Spanish Government officials are doing their utmost to bring about a settlement. Some of the men have gone back to work. Many who have the means are emigrating to America.

Portugal.—A company has been formed, called the Ervedosa Tin Mines, Limited, for the purpose of acquiring the property of a French company of similar name, situated on the river Tuella, near the town of Mirandella. Directors of Cooksons and of the Eastern Smelting Company are on the board, and a report has been made by Mr. Josiah Paull. The ore-bodies are large and of low grade, averaging 0·7 to 1% of tin, of which 70% is recoverable. The ore can be worked by quarry, so that there are no pumping or hoisting charges.

Spitsbergen.—The bid for the property of the Northern Exploration Company, mentioned last month, came from a Swedish group, which is supposed to have German backing. The Foreign Office intimated to the company that such a deal would be to the detriment of Norway, to whom the sovereignty of Spitsbergen was granted recently, so the company is once more left to its own resources in the matter of raising further capital.

THE MINES AND MINERALS OF YUNNAN
SOUTH CHINA.

By J. COGGIN BROWN, O.B.E., D.Sc., M.Inst.M.M., F.G.S.

Geological Survey of India.

The author gives a description of the mineral resources of Yunnan, the most south-westerly of the Chinese Provinces, adjoining Burma and Tongking.

INTRODUCTION.—Yunnan is the most south-westerly of the provinces of China. It has an area of about 150,000 square miles and a population of approximately eleven millions, of whom roughly one-third are Chinese. On the west it is bounded by Burma, Assam, and Tibet, on the north by Ssu-ch'uan, on the east by Kuei-chou and Kuang-hsi, and on the south by Tongking. Apart from its size, population, and the political significance of its frontiers, marching as they do for hundreds of miles with both British and French possessions in Asia, Yunnan is important as the connecting link between Burma and the valley of the Yang-tze. If India and China are ever connected by a railway, the line must pass through Yunnan. The province yields a great variety of natural products, and its mineral industry only needs transport facilities and the application of modern knowledge to make it of first-rate importance. In the course of my duties as an officer of the Geological Survey of India, I have made extensive journeys throughout the country, have studied its geological features, and have investigated its mineral resources. I am indebted to the Editor of THE MINING MAGAZINE for the present opportunity of summarizing my official reports, and of drawing attention to the potentialities of an important though comparatively unknown land.

GEOGRAPHY.—Western Yunnan, lying between the Burma frontier and the Mekong, is occupied by the north and south-running ranges separating the upper valleys of the Irrawaddy, Salween, Mekong, and Yang-tze. In the north-west these ranges attain heights of 15,000 to 20,000 ft. above sea level, and the minimum elevation of the rivers is about 7,000 ft. Further south the heights decrease, and elevations of 5,000 to 7,000 ft. prevail in the Mekong ranges, the river itself being nearer 2,000 ft. Central Yunnan is built up of a series of ridges forming a compressed arc turned toward the south, the higher peaks of which are from 9,000

OUTLINE MAP SHOWING POSITION OF YUNNAN.

to 14,000 ft. above the sea. The drainage flows into the Mekong and Red Rivers on the south, and into the Yang-tze on the north, often through deeply-dissected gorges. In Eastern Yunnan a series of irregular mountain chains trend north-north-east and south-south-west. Toward the north, heights of 8,000 to 11,000 ft. are reached. Further south in the region of the lakes, ridges of 6,000 to 8,000 ft. are the rule. Characteristic of Yunnan are its fertile plains, small, flat-bottomed valleys lying among the mountains. They occupy about one-fifteenth of the total area and support one-third of its population. Practically all the walled cities are built on such sites at elevations of 5,000 or 6,000 ft., with the ranges rising 3,000 or 4,000 ft. above them.

INTERNAL COMMUNICATIONS. — Yunnan suffers from lack of efficient ways of transportation. Though some of the greater rivers of the earth traverse it, they are of no practical service for boat transport. They flow swiftly in rocky channels, liable to seasonal floods and often at the bottom of precipitous cañons. Wheeled traffic is non-existent, and goods are carried by pack mules, or, more rarely, by bullock trains and porters. The roads of Western China have been abused by every traveller from Marco Polo onward. Zigzagging up the mountain sides and wandering over the plains, these paved roads extend for thousands of miles. Skilful engineering feats for the period in which they were made, the physical character of the country and the inertia of its Administration are jointly responsible for their condition today. "Good for ten years and bad for a thousand" is an appropriate Chinese maxim regarding them.

TRADE ROUTES.—There are four great arteries of communication between Yunnan and the outside world. These are the following:

(1.) The Bhamo-Têng-yüeh route, which is the main trade road connecting Bhamo with Têng-yüeh, Tali Fu, and Yunnan Fu, the capital of the province.

(2.) The Tongking-Yunnan railway, which starts at Haiphong on the Gulf of Tongking, runs to Lao-kai on the frontier, and thence to Yunnan Fu.

(3.) The Yang-tze route, which passes through the heart of China. Steamers can ascend to I-chang, and thence junks proceed to Sui Fu in Ssu-ch'uan, only one stage by road from the Yunnan boundary. The Yunnan portion of this route claims the distinction of being the most difficult and most inhospitable of any of the main roads of Western China.

(4.) The West River route, which leads up the West River from Canton, through Kuang-tung and Kuang-hsi to the borders of Yunnan. Boats can ascend to Pai-sê T'ing, one day's march from the Yunnan border.

Other roads enter the province, but they are not to be compared in importance with those mentioned.

PREVIOUS WRITERS.—In the account of Doudart de Lagree's journey through Indo-China in 1866-1868, B. Joubert has given some account of the geology of the parts of Yunnan crossed by the expedition. ("Voyage d'Exploration en Indo-Chine," vol. 2, pp. 173-264. Paris, 1873.)

A Chinese work by Ou-ki tche, at one time Viceroy of Yunnan, and Hu-kin-sen, Prefect of the city of Tung-chuan Fu, was written in 1850. It is entitled "Tien nan kouang tchang toulou," and deals with the production of metals in Yunnan and the means employed by the Chinese for their extraction and treatment. A translation of this important work into French has been made by a Chinese scholar named Ko, and it appears in the account of Doudart de Lagree's mission mentioned above.

Rocher in 1880 gave some account of the mines of the province and Chinese metallurgical methods of the early seventies. ("La Province Chinoise du Yunnan," 2 vols. Paris, 1880.)

Von Loczy, a geologist attached to Count Szechenyi's Chinese expedition, made a rapid traverse through a portion of Yunnan in 1879. His work was purely geological. ("Die Wissenschaftlichen Ergebnisse der Reise des Grafen Bela Szechenyi in Ost-Asien," Vienna, 1892.)

Duclos accompanied the Lyons Mission in various parts of China during the years 1895-1897, and has published a report on the mines and metallurgical industries of Yunnan, Kuei-chou, and Ssu-ch'uan. ("La Mission Lyonnaise d'Exploration Commerciale en Chine," Lyons, 1898, pp. 283-314.)

Leclère, "Ingénieur en chef des Mines," acting in touch with the mission under Guillemoto which had for its object the question of the extension of the railways of Indo-China into China proper, made extensive traverses in the provinces of Yunnan, Kuei-chou, and Kuang-hsi about 1898. ("Étude Géologique et Minière des Provinces Chinoises Voisines du Tonkin," *Annales des Mines*, vol. xx., 1901, pp. 287-492.)

Monod, "Chef adjoint de service géologique de la colonie," also toured in Yunnan about the same time as Leclère. ("Contribution à l'Étude Géologique de la Chine Méridionale," *Bull. Econ. Ind. Chine*, vol. xxxiii., 1898.)

Logan Jack has published an account of his travels through China to Burma while escaping from the Boxer rising of 1900. Dr. Jack mentions the mineral deposits he happened to come across. ("The Back Blocks of China," London, 1904.)

Lantenois, "Ingénieur en chef des Mines et Directeur du Service des Mines de l'Indo-Chine," undertook the investigation of the mineral questions connected with the definite choice of a route for the Tongking-Yunnan railway about 1903. ("Resultats de la Mission Géologique et Minière du Yunnan Méridional," *Annales des Mines*, vol. xi., 1907, pp. 298-503.)

Davies, author of the most important work on Yunnan which has yet appeared, has referred to the mines seen by himself or members of his parties. ("Yunnan, the Link between India and the Yang-tze," Cambridge, 1909.)

Deprat and Mansuy, members of the French Geological Service of Tongking, surveyed large tracts of Eastern Yunnan during the years 1909-1911. ("Mémoires du Service Géologique de l'Indo-Chine," vol. i., pts. 1-3, 1912.)

The geological results of my own work have been published from time to time in the Records of the Geological Survey of India.

GEOLOGY.—Crystalline rocks form a zone about 70 miles wide, stretching from the Burma frontier to the Irrawaddy-Salween divide. They are probably a continuation of the gneiss of the Northern Shan States and the Ruby Mines district of Burma. The typical rocks are grey gneisses and schists of various kinds, containing bands of crystalline limestone and intruded by granite. Similar rocks occur in the T'sang Shan range near Tali Fu, between Shunning Fu and Mien-ning T'ing and in the Yangtze valley near its confluence with the Ya-lung. In the neighbourhood of Ko-chiu in south-eastern Yunnan, masses of leptynite are intruded by tourmaline pegmatites which have yielded the well-known cassiterite deposits.

Between these basal crystalline rocks and the overlying Palæozoic sediments there is an ancient metamorphosed series of phyllites, slates, and quartzites with subordinate calcareous bands, to which I have given the name Kao-liang System.

Cambrian fossils have been found in slates in Eastern Yunnan by the French geologists, while rich faunas of Ordovician age and a few Silurian graptolites were discovered by me in the western part of the province.

Limestones belonging to the Devonian, Carboniferous, and Permian systems occur throughout the country, and indeed build up the greater part of eastern Yunnan. The middle Carboniferous attains an exceptional development in the east, where it also carries sandy horizons with coal seams.

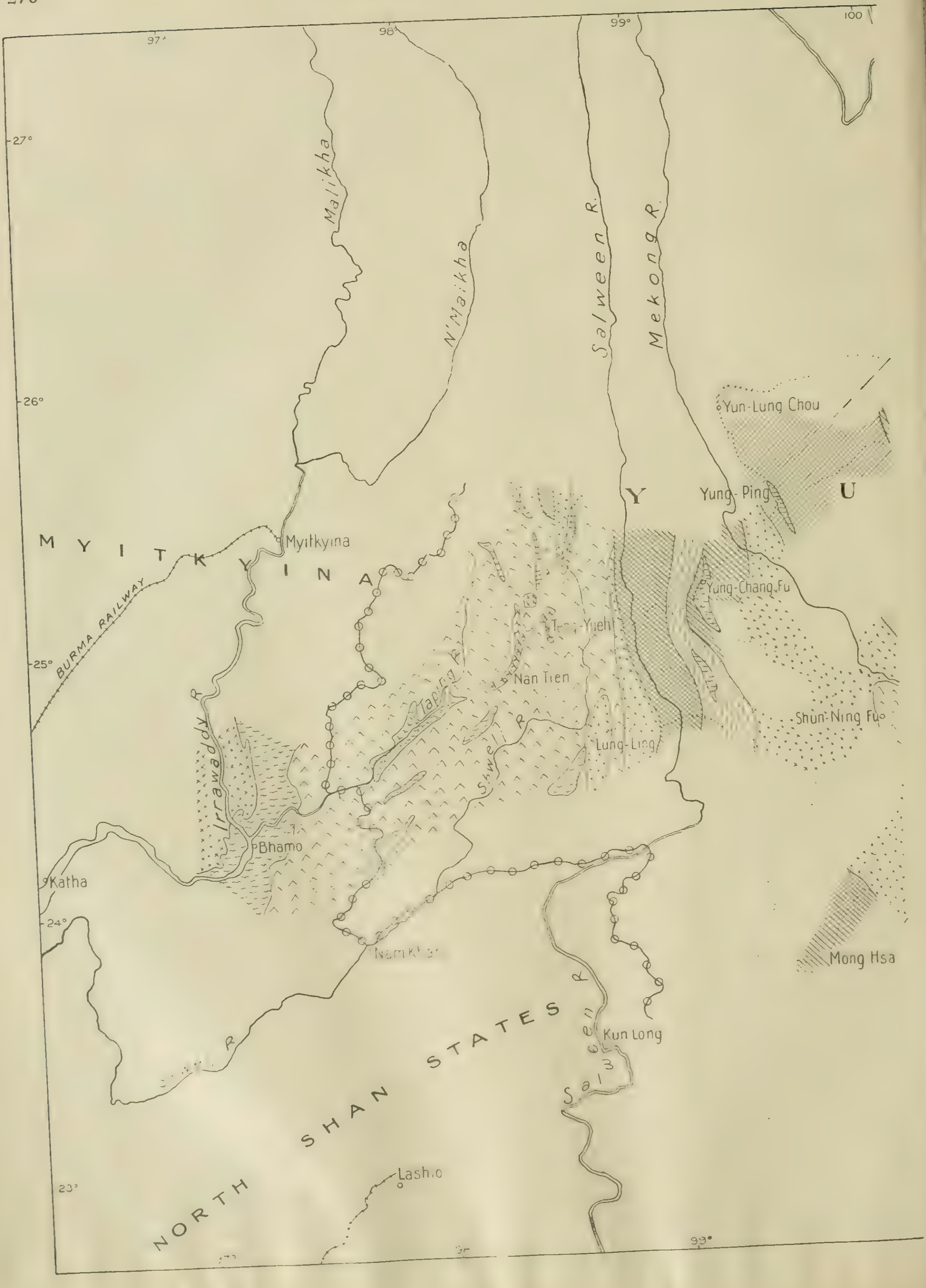
A well-marked unconformity separates the limestones from the Upper Permian or Red Beds Series which forms the greater part of Central Yunnan. It consists of red sandstones and red, purple, and green shales not unlike certain facies of the Indian Gondwanas. The lower beds of the series contain thick bands of rock salt and gypsum.

Triassic strata come above the Red Beds. They have been preserved in certain areas by faulting, which has let them down into the older rocks. The three great divisions of the system are well represented, especially in eastern Yunnan, and each of them contains coal measures, the most valuable being in the Lower Trias.

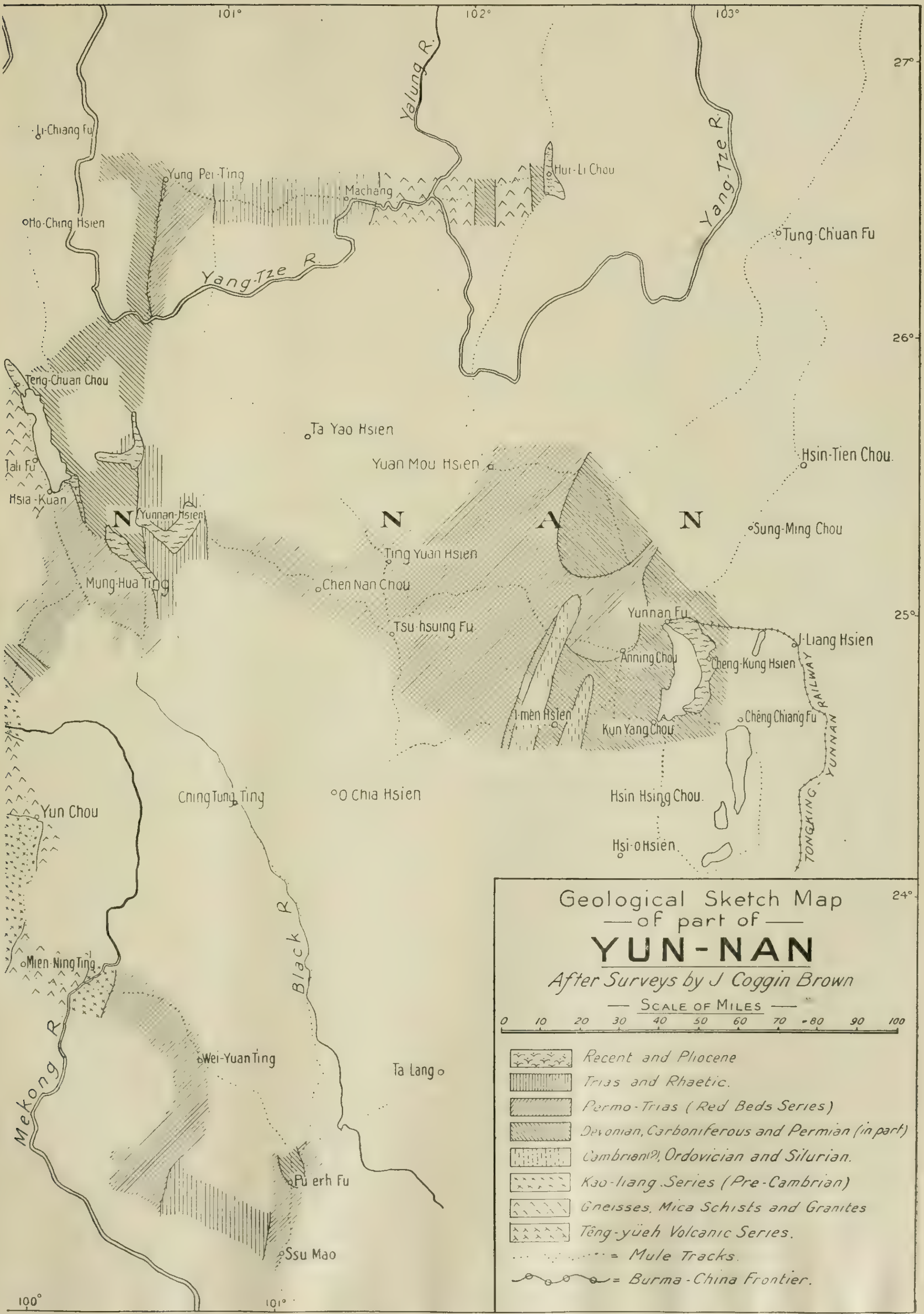
Yunnan has probably been a land area from Upper Trias times. The only known deposits of later age are the lake beds of the Tertiary period. Deposition is still in progress in some of these. They consist of sands, sand-rock, clays, and pebble beds with seams of lignite in places.

CHINESE MINING METHODS.—Mining and metallurgy in China must not be regarded from the standpoint adopted when considering these arts elsewhere. Separated from the rest of the world throughout a very long period of isolation, the Chinese have had to evolve for themselves methods of winning and concentrating ores and of smelting and refining the metals from them. In doing so they have developed a complicated form of mining administration. Modern indigenous methods in Yunnan are those of the ancestral Chinese. Their theories of ore deposition are purely magical. They erect shrines and make appropriate sacrifices at appointed intervals to the spiritual patrons of the mines, on the principle that it does no harm and may do good; yet they are skilful prospectors, capable miners, and resourceful metallurgists, but strictly limited by their ignorance of effective means of contending with the natural difficulties which beset the miner constantly.

Under the Manchu Government there was a central office, a kind of mining bureau, in Yunnan which used to regulate affairs in which the authorities took a special interest, as, for example, the copper mines. The direction exercised was purely fiscal and not technical in any way. Officials were deputed to each important mining centre to collect the various revenues, in cash or in kind for which each district was assessed, and to forward them promptly to headquarters.



97°
98°
99°
100
27°
26°
25°
24°
23°
Malikha
N'Maikha
Salween R.
Mekong R.
Yun-Lung Chou
Y
Yung-Ping
U
M Y I T K Y I N A
Myitkyina
BURMA RAILWAY
Yung-Chang Fu
Nan Tien
Shun-Ning Fu
Irrawaddy R
Shweli R
Lung-Ling
Bhamo
Katha
Mong Hsa
NORTH SHAN STATES
Kun Long
Salween R
Lashio
99°



Geological Sketch Map
of part of
YUN-NAN
After Surveys by J Coggin Brown
Scale of Miles
0 10 20 30 40 50 60 70 80 90 100
Recent and Pliocene
Trias and Rhaetic.
Permo-Trias (Red Beds Series)
Devonian, Carboniferous and Permian (in part)
Cambrian(?), Ordovician and Silurian.
Kao-liang Series (Pre-Cambrian)
Gneisses, Mica Schists and Granites
Tĕng-yüeh Volcanic Series.
= Mule Tracks.
= Burma-China Frontier.
Li-Chiang Fu
Yung Pei Ting
Machang
Hui-Li Chou
Ho-Ching Hsien
Yalung R.
Yang-Tze R.
Tung-Ch'uan Fu
Teng-Chuan Chou
Ta Yao Hsien
Yuan Mou Hsien
Hsin-Tien Chou.
Tali Fu
Hsia-Kuan
Yunnan-Hsien
Sung-Ming Chou
Ting Yuan Hsien
Mung-Hua Ting
Chen Nan Chou
Tsu-hsuing Fu
Yunnan Fu
I-Liang Hsien
Anning Chou
Cheng-Kung Hsien
I-men Hsien
Kun Yang Chou
Chêng Chiang Fu
TONGKING-YUNNAN RAILWAY
Ching Tung Ting
O Chia Hsien
Hsin Hsing Chou.
Yun Chou
Hsi-o Hsien.
Mien-Ning Ting
Black R.
Mekong R.
Wei-Yuan Ting
Ta Lang
Pu erh Fu
Ssu Mao
100°
101°
102°
103°
27°
26°
25°
24°

A small proportion of the population undoubtedly regards mining as its hereditary occupation, and its professional spirit is kept alive by the various guilds and societies. But the great majority of the mining labour comes from the ranks of the agricultural community. They are members of peasant families driven off their farms by overcrowding, or some other cause, or else they are aborigines recruited from one or other of the numerous mountain tribes. Every important field draws its labour from a particular district. The Ko-chiu tin miners come from Lin-an Fu, Chen-nan Chou used to supply the Burma Ruby Mines, while Bawdwin obtains its miners from Ho-hsa and La-hsa, or the neighbouring Chinese Shan States. It deserves to be more widely known what good mining coolies these men make under sympathetic management.

The internal demand for metals in Western China has resulted in a state of affairs which is unparalleled in any other Eastern country. I refer to the fact that the greater portion of the surface of the land has been prospected. It is no exaggeration to say that to all intents and purposes the deposits of metallic ores, with the extraction and uses of which the Chinese are acquainted, or which can be successfully treated by their methods, are known. In other words the engineer of the future, be he European or Chinese, will not be concerned so much in searching for new deposits as in proving the value of the deeper-seated portions of those worked in the past.

COPPER.—Copper is said to have been smelted in Yunnan for a thousand years, and the province is supposed to have supplied the greater part of the metal used in the coinage of China. It is certain that a Government Department controlled all operations in the mining, smelting, and marketing of copper for centuries. Under the Manchus all the mines were regulated by the authorities who granted licences for mining, fixed the price of the metal annually, and strictly supervised the industry generally.

A Chinese official work, written about 1850, enumerated 35 important copper mines as well as many smaller ones. They are classified among 13 prefectures of the province, and figures are given showing the amount of tribute copper which each one was compelled to supply free to the Government. From it we learn that 10% of the total production was demanded for the Pekin authorities. The local officials were held responsible for this, and had to make good any shortage in the amounts assessed by the Bureau of Mines. Another 4% was taken for provincial purposes, and a third tax of 10% was levied to meet transport costs and road maintenance. No less than 24% of the copper output was thus requisitioned by the Government.

This Chinese work became obsolete many years ago owing to the exhaustion of some of the mines and the general abandonment of mining during the Yunnan rebellion, which broke out in 1854 and was not quelled until 1873. In the general devastation of the country during these years the mining industry received a check from which it has not yet recovered. According to this treatise, about the year 1850 the contributions of metallic copper for imperial and provincial purposes amounted to 6,000 tons. Too great a reliance should not be placed on Chinese statistics of this sort, but it may be asserted that copper mining was very important about the middle of the 18th century.

The French metallurgist, Rocher, travelled in Yunnan from 1871 to 1873. From his accounts it is gathered that after the commencement of the civil war the production of metals fell to practically nothing, and that when order had been re-established, the Government hesitated to permit mining to be started again through fear of fresh disorders. Rocher states that the copper mines he visited were the deepest of any he examined, and he gives a description of the methods adopted in smelting.

Duclos, who visited Yunnan in 1896, states that at that time the annual production had fallen from 5,000 tonnes per annum of the decades before the rebellion to 1,100 tonnes. He gives a list of mines from which this output was obtained. The most important are in the Tung-ch'uan Fu prefecture.

Leclère, writing in 1898, estimated the annual production at the end of the 17th century at 6,000 tonnes, and at the time of his visit to the country at from 1,000 to 1,500 tonnes of metallic copper. Regarding the ore deposits he wrote that the ores bornite, covellite, and more rarely copper pyrites are found in slates of Carboniferous age, but that such occurrences are practically abandoned. Layers of cuprite and native copper intercalated in porphyrite are very much esteemed, but the absence of explosives often makes them unworkable. Sandstones impregnated with copper carbonates are said to be found in the Trias. The principal centres are Tung-ch'uan Fu and Wei-hsi T'ing in Kuei-chou. The smelters will only accept minerals capable of producing a matte containing 20% to 30% of metallic copper. The ores are handpicked at the mines to bring this about. Ores which do not contain more than 15% copper are thrown away and form dumps of considerable size. Large quantities of slags containing 3% copper must exist in the old smelting centres. These and other facts are held by Leclère to prove that Yunnan possesses considerable reserves of copper-bearing minerals, chiefly in inaccessible districts. Only general conclusions can, however, be drawn, and a special study of each deposit is essential before its value can be determined.

COPPER MINES OF NORTH-EASTERN YUNNAN.—I have not visited the important copper-producing district of Tung-ch'uan Fu. The following notes are from the writings of Leclère (1898) and Deprat (1910).

The Lou-pou mines are in Carboniferous porphyries. One of the flows contains a flat band of barytes carrying native copper and its oxides. Workings are started on the flank of a hill, at points where the ore-bearing layer is thick enough to permit the driving of a low adit without breaking into the igneous rock. Mining only commenced in 1897. It is difficult to arrive at any conclusion about the value of the deposit because the thin portions are not worked. Masses of native copper too large to be brought out of the workings are left behind. About 100 men were employed. The picked ore contained 20% to 40% of copper, and production was not more than half a tonne per day.

The principal copper deposits of the district are comprised within the Tang-tan group, near the village of Ta-me-ti. In 1898 there were four principal mines:

(1) Sin chang, a little above and to the west of Ta-ho. 300 miners were formerly employed here, but in 1898 work was abandoned owing to the distance of the mine from the smelters.

(2) Pe-si-la, a lode in the Carboniferous, 18 kilometres west of Ta-me-ti. At one time it gave employment to 300 men, but was abandoned in 1898 for the same reason as in the previous case. It was managed by Japanese working on European lines.

(3) Lao-sin-chang, 4 kilometres west of Ta-me-ti. Employed 200 men.

(4) Lao-chang, with Lao-min-tsao and Sin-min-tsao. These are close to Ta-me-ti and found work for 1,100 men.

At Lao-chang there is a kind of stockwork. The ore was originally copper pyrites, but entirely altered to carbonate with concretions of barytes. The limestone massif is pierced by more than 300 workings, and drives up to 1,500 metres in length had been made on the best veins. Ores containing 20% copper are accepted by the smelters, but poorer material did not pay for treatment, owing especially to the high cost of the charcoal fuel which had to be brought from forests four days' journey away. The ore from Lao-sin-chang was almost entirely copper pyrites. That from Pe-si-la was mainly bornite with a little covellite. It was a difficult ore to smelt by the local methods. The Japanese attempted a preliminary roasting, but the scarcity of fuel made operations impossible and the deposit was considered unworkable. The slags obtained by the Japanese only contained a trace of copper. The ancient slags contained 3%, but those in the vicinity of the smelters in 1898 had been retreated. The Japanese worked 8 furnaces, but there were others scattered about the district under the charge of subordinate Chinese officials. The total production of Tang-tan was about 500 tonnes per annum. The crude copper was sent to Tung-ch'uan Fu for refining. Part of the finished product was sent to Pekin and the remainder to Kong-chan where a mint had been installed. The Chinese officer in charge of the copper business of the Prefecture informed Leclère that the Japanese had spent a sum equivalent to four millions of francs in twelve years on the construction of the smelter, the establishment of a number of roads, and the exploitation of the Pe-si-la deposit. The enterprise had not reached a profitable stage when the Chinese-Japanese war ended it. Copper manufacture was then started by the Chinese authorities again.

Twelve years later, in 1910, Deprat visited the Lao-chang region. He found that of the four groups already mentioned only Lao-sin-chang and Lao-chang were being worked, the others having been abandoned. The Lao-chang deposit is formed in the fissures of cracked and brecciated limestone. The original pyritic mineral had been transformed into carbonate, as Leclère indicated, with abundant concretions of banded barytes. The limestone mass is riddled with innumerable workings following the lines of fracture, and the labour force employed was much the same as before. The output was 576 tonnes per annum, and the crude metal was still being refined at Tung-ch'uan Fu before shipment to Pekin.

Deprat refers to other copper-bearing localities in the same district, two of the more important being Lo-suy where copper carbonates occur in a thin lode traversing Cambrian schists, and Mo-lo-chang where chalcopyrite and copper carbonate are disseminated in thin quartz veins cutting sandstones and shales.

COPPER DEPOSITS OF EASTERN YUNNAN.—Numerous copper deposits in Eastern Yunnan have been described by Leclère, Lantenois, and Deprat, but none of them appear to be of any great importance. According to Lantenois (1903), they are all in more or less direct association with eruptive rocks, such as andesites and basalts. He distinguished the following four types:

(1) In contraction fissures and cracks of the eruptive rocks.

(2) Pocket deposits at the contacts of eruptive rocks and limestone.

(3) In irregular fissures in limestone in the vicinity of eruptive rocks.

(4) In more or less open fractures across limestone and shale.

At the Wei-tou-chan mine, 10 kilometres south of Mien-tien, a small town 20 miles east of Lin-an Fu, a thin vein following an irregular fissure in an eruptive rock, carrying quartz rich in bornite, chalcopyrite, and pyrite, is exploited. The extracted ore contained 20% to 25% of copper. In 1905 about 70 men were employed here, and the production was 60 tonnes of metallic copper per annum.

The Tien-pao mine is situated near Pe-tchen, which is a few miles north-east of Hsin-hsing Chou, in the Ch'eng-chiang Fu prefecture. About 1893 it is believed to have found employment for 1,000 men and to have produced 300 tonnes of copper per annum. In 1893, however, owing to the fact that mining had become hindered by the depth of the workings, only 40 men were employed and the annual output was not more than 30 tonnes. There were three interstratified ore bands with sandstone floors and shale roofs. The bands were 0·3, 0·5, and 0·6 metres in thickness respectively, but only one of them was being worked. The ore was found in the form of balls rich in copper carbonate. It was hand-picked and washed, and yielded 20% of copper on smelting. Both Lantenois and Deprat consider that this deposit deserves attention.

The mines in the vicinity of Lu-nan Chou have been abandoned for 50 or 60 years. There are indications of 16 sets of old workings scattered around various localities, and they are either in the eruptive rock or at its contact with limestone. Large slag heaps exist, but they are not held to prove that the mines were important.

At the contact of the basalts and the Uralian limestone of the Po-hsi neighbourhood, small fractures containing copper carbonate have been mined, but they are of no economic interest. On the Devonian limestone plateau, between Lan-nin-tsin and Ta-me-ti, there are numerous small prospects on nests of ore in the limestone or the eruptive rock. They are distributed in such an irregular manner that large-scale operations are out of the question.

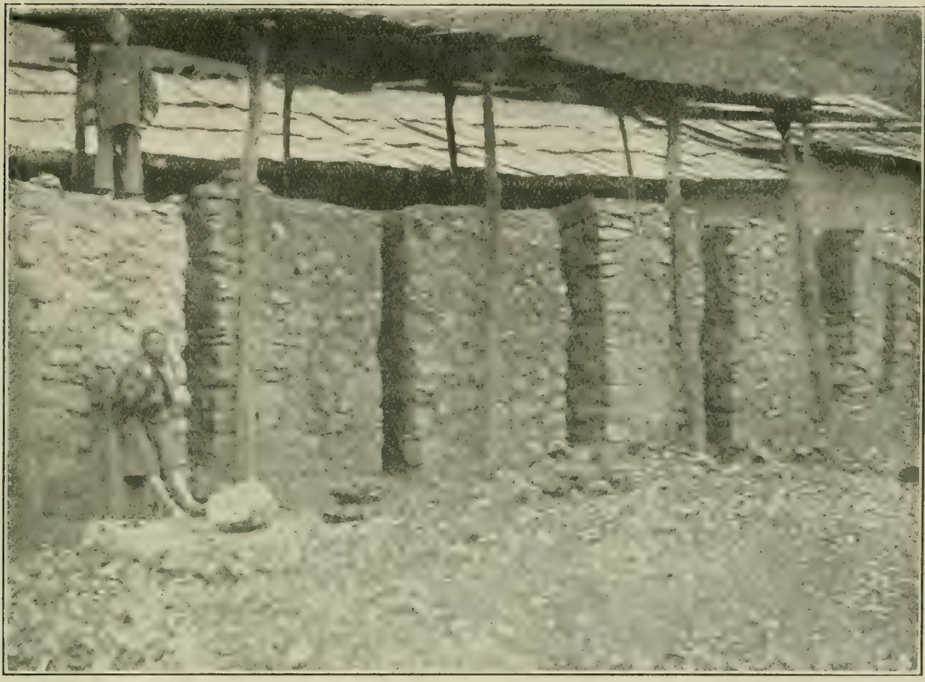
Deprat has concluded that the copper deposits of Eastern Yunnan, within reach of the Tongking-Yunnan Fu railway, are not encouraging, and that the geological conditions are such as to confirm unfavourably the impressions furnished by the mines themselves. There are copper ores in the basic eruptives of the Permian and Moscovian, but the deposits are restricted and incapable of giving an output of any duration or size. Speaking generally, he believes that between Mêng-tzu and Yunnan Fu conditions offer little encouragement; the crushing and folding of the rocks in the Himalayan movements almost completely dispel the hope of finding large mineralized fractures in them.

COPPER MINES OF THE YUNG-PEI T'ING DISTRICT.—Yung-pei T'ing lies seven days' journey to the north-north-east of Ta-li Fu at an elevation of 7,300 ft. above sea level and the mines lie to the west of the city in the direction of the Yang-tze. The river flows in a north and south course, six or seven miles further west, between two well-marked though short ranges running parallel to it. Between these there is a series of lower cross spurs, separating the drainages of the smaller tributaries. Pao-p'ing-ch'ang is situated almost on the crest of one of these, dividing the watersheds of the Wu-lang Ho and the next stream, which joins the Yang-tze 20 or 30 miles further south.

The country is built up mainly of limestones and contemporaneous igneous strata of Permo-Carboniferous age, the decomposed outcrops of the flows being seen in the gullies where the watercourses have removed the overburden, but, as a rule, a red clayey soil covers the ground and forms the smooth outlines of the rounded mountain tops. There is a little pine forest, but most of the trees have been cut down for charcoal manufacture.

Pao-p'ing-ch'ang is a typical Chinese mining camp. The sides of the valley are covered with dumps and have been dug up repeatedly in search of ores. The entrances to the levels are perched in all kinds of places on the steep slopes, the spoil heaps forming long glissades down to the stream far below. Great accumulations of copper slags are scattered around. The village is small and badly built, the water supply is poor, and stores of every kind have to be carried in from a distance.

The youngest rocks in the neighbourhood are the white limestones of Permian (?) age which surmount the tops of the hills to the



Kilns for Roasting Copper Ores at Po-P'ing-Ch'ang.

Blast-Furnaces for Smelting Copper Ores at Po-P'ing-Ch'ang.

north and north-west. The dark fossiliferous limestones of the Permo-Carboniferous come below them, and are themselves underlain by a thick series of shales and sandstones of various colours. The portals of the tunnels go through these rocks. In association with them is the volcanic series, made up of lavas, tuffs, and ash beds, with layers of shale and grit between them. The lavas are often greatly altered at the surface, and it is not always easy to distinguish their true characters.

There are very numerous old workings in the valley, but the deposits which were being worked were entered from both sides of a spur which cuts into and narrows the valley. The mines are from 1 to $1\frac{1}{2}$ miles from the camp, to which they are joined by a good mule track. I inspected the workings entered from the south side. These underground workings were of great extent. It is quite impossible to describe them in detail, forming as they did a perfect labyrinth. Suffice it to say that the actual working had been conducted with great skill and betokened considerable experience. The ventilation in the main ways was good, but in the remoter parts of the mine the air was very foul. There was not much water except in the lowest levels, and it was raised to the drainage adits by means of bamboo pumps. The general impression I received was that the mine was about exhausted as far as it was possible for the Chinese to go down. There was no systematic plan of operation, and thin quartz stringers were being followed in all directions. These carried sulphide ore in the form of erubescite with smaller quantities of chalcopyrite. Chalcocite, malachite, and azurite were also identified. In one part of the mine an old stope indicated the former presence of a vein 5 or 6 ft. thick. The miners confirmed this and said that it ran out 10 or 15 years earlier. Decomposition and metamorphism of the country rock had been profound, and it was impossible to arrive at any conclusions regarding the origin of the ores during the short time I was permitted to stay in the mine. I am inclined to think that the veins were in very irregular fissures of great variation in size, traversing shales, sandstones, and limestones, and also entering the eruptive rocks in contact with them.

The ores are carried to the surface in baskets by boys, and after the large pieces have been broken up, the material goes to the sorting tables, each of which finds employment for 8 or 10 women, who are very skilful at the work. The rich pieces were picked out and placed in baskets and the remainder went to the dumps. The latter are mainly gangue and low-grade ores, disseminated sulphides and carbonates. The water percolating through the dumps was of a bright blue colour, and appeared to bear an appreciable quantity of copper salts in solution.

The rich picked ores, consisting chiefly of erubescite and chalcopyrite, are carried down to the smelters in the village. There they are roasted in large quadrangular kilns for three days, with ironstone, charcoal, and wood. The caked masses from the kilns went into the large blast-furnaces, the smalls and dust were washed, the heavier portions kept and smelted in a special furnace of smaller dimensions. Three sizes of blast-furnace were made use of, generally in benches of six. The largest were from 20 to 25 ft. high, but with a long opening in front, above the wall of the hearth. The other furnaces were about 15 ft. high, and there was also a still smaller type. The smelting operation took three days to complete in the largest furnaces, working day and night, and twelve hours in the smallest type. The blast was supplied from large cylindrical blowers worked by relays of coolies. The molten metal was not tapped, but when the reaction was completed the front of the furnace was broken in, leaving a bath of molten metal in the bottom of the hemispherical hearth. This was allowed to cool, and the process was hastened by spraying rice water on to the hot surface, which, as it solidified, was removed in plates. The charges for the largest furnaces were said to be as follow: Calcined ore 3 tons, iron ore $1\frac{1}{2}$ tons, charcoal 3 tons, limestone $1\frac{1}{2}$ tons. The amount of copper produced, according to my Chinese informant, was anything from $\frac{1}{5}$ to $\frac{1}{2}$ ton.

The mines are said to be over 200 years old. About 100 years ago they are said to have produced some 1,700 tons of copper per annum, and to have found employment for 5,000 men Later on production had dwindled to 110 tons per annum. In 1907 only 20 tons were produced, rising to 60 tons in 1909. About 1900 the total output of all the copper mines of the Yung-pei T'ing district was about 150 tons per annum, but 6 years later this had fallen to approximately 30 tons. The operations at Pao-p'ing-ch'ang were controlled by a small syndicate which found employment for about 250 men.

Copper ores are worked at the following localities in the Yung-pei T'ing district: Mu-erh-p'ing-ch'ang, Ta-pao-ch'ang, Pa-sa-la, Hsi-si-ti, and Tung-ch'ang-ho. Some of these are merely prospects, finding employment for a few miners, and they are all situated from one to three stages to the south of Pao-p'ing-ch'ang in the unsurveyed country between it and the Yang-tze.

At Yung-pei T'ing I obtained information, on good Chinese authority, that the following localities in the Li-chiang Fu prefecture, bordering Yung-pei T'ing on the west, produce copper ores: Hei-pei-shui, Ku-ho, and Lo-tzu-chüeh.

SAN-CHIA-CH'ANG COPPER MINE.—This small copper-producing centre is situated five stages to the south-west of Yunnan Fu, in the upper valley of the eastern head waters of the Red River of Tongking. The hillsides are covered with screes of bluish-grey slates, but on the opposite side of the river limestones crop out. The latter are exceedingly broken up near their contact with the slates. The river flows in a gorge at an elevation of 4,000 ft. approximately, but within four miles on either bank the ranges attain heights of over 8,000 ft. There is a great limestone precipice rising up behind the village, and it is noteworthy that rolled blocks of a red granite were seen in the stream bed.

When Duclos visited this locality in 1897 he found that only one furnace was in operation, and this was the state of affairs at the time of my own inspection, although it is well known that before the Mohammedan revolt several more were in existence. In 1897 the annual production of copper was only about 40 tons, and I believe that this amount had considerably decreased at the time of my visit. The main entrance to the mine was high up on the mountain side, about 1½ miles south of the village. It took me over half an hour to reach the first working place. The country rock is an altered limestone, and the ore chalcopyrite with small amounts of enriched sulphides. According to Duclos several well-marked lodes exist, but the ores I saw occurred in badly defined and rather thin zones of impregnation. However, I was only able to examine a small part of the mine. About 20 men were employed, and all low-grade ore was thrown on to the dumps. I doubt if there is much left in those parts of the mine which the Chinese have reached, but it might be worth examining to see if the deposits extend to any greater depths.

TA-TSANG-KUAN-MIAO COPPER PROSPECT.—This locality is situated about 2 miles to the east-south-east of Ta-tsang-kai, a village 10 miles north of Mêng-hua-T'ing on the Ta-li Fu route. The country rock consists of soft red and white sandstones, interbedded with grey shales belonging to lower horizons of the Red Beds series. The shales contain pieces of bornite, about the size of a pigeon's egg, coated with thin crusts of decomposition products. Exploratory workings were being made in search of the ore. An old copper mine is said to exist at Hua-pang to the north-west of Ta-tsang-kai, and copper ores are said to be mined and smelted at Kung-lang, a large village on the northern side of the Mekong, about half-way between Mêng-hua T'ing and Yun Chou.

SHA-HO-CHANG COPPER MINE.—This place is about 15 miles to the north-north-west of Yung-ch'ang Fu as the crow flies, across the Mekong-Salween divide. In the vicinity, greenish slates and phyllites with a few bands of sandstone are intruded by an altered basic rock. Ancient slag heaps of considerable extent occur, and the mine was said to be in a very flourishing condition thirty years earlier. At the time of my visit about 70 men were engaged in reopening old workings. The hand-picked ore, mainly chalcopyrite, was smelted on the spot in a large blast-furnace of the type already described.

OTHER COPPER LOCALITIES.—The district of Hui-li Chou, now in the province of Ssu-ch'uan but which formed part of Yunnan at one time, is famous for its copper mines. According to Davies there is a mine at Lu-ch'ang, 6 miles south of the town. Mr. Way has mentioned others in a recent article in THE MINING MAGAZINE (July, 1916). I noticed small heaps of copper slags at several places on the southern route between Hui-li Chou and the Yang-tze. Davies believes more mining might be done in the northern part of the Hui-li Chou valley if the Lolo country to the east was more settled. It is interesting to note that all the copper smelting of this region is done with coal or coke.

Copper ores also occur in the Wei-ning Fu district of the Kuei-chou province, but the town is only 20 miles from the eastern frontier of Yunnan. The only importance of the district is said to consist in its copper, lead, silver, zinc, and iron mines.

(To be concluded.)

French Coinage.—In spite of considerable variance of opinion, it has been decided by the French authorities to issue through the Chambers of Commerce a token franc made of aluminium-bronze. The reason for this step has been the scarcity and dearness of silver and the objection to the present large issues of paper money of small denominations. The tokens are about the size of a penny, but much thinner.

THE BEARING OF THE DISTRIBUTION OF CERTAIN METALLIC MINERALS ON THEIR GENESIS

By J. D. KENDALL.

The author discusses the origin of the iron ores of Cumberland and Furness

In the Memoir of the Geological Survey, vol. viii, Iron Ores, Hematites of West Cumberland and North Lancashire, p. 31, it is stated that "the solutions were introduced from above." On p. 44 we read: "North of Arlecdon and Lamplugh little success has been attained in finding ore in workable quantity. This is probably due to the occurrence of Coal Measures and Millstone Grit between the New Red Brockram and the Carboniferous Limestone." These quotations are, I think, sufficient to show that the writer of the Memoir was of opinion that the source of the hematite deposits was the iron oxide in the Triassic rocks, which at one time overlay those of Carboniferous age to a larger extent than they do to-day. This idea has been held by several geologists, who, however, had only a nodding acquaintance with either district. Such a view, if held by those having the direction of explorations, would lead to a great waste of time and money. To prevent that is the object of this communication, wherein it will be shown that the supposed downward filtration from Triassic rocks could not have originated our hematite deposits.

To set out clearly the reasons for the latter statement it will be necessary to look through a few pages of the geological history of the Lake District and the immediately surrounding country. Fig. 1 is a part record thereof. It will help to a better understanding of the remainder considered necessary to this inquiry.

The oldest rocks of the district are the Skiddaw slates, mainly Lower Silurian but probably part Upper Cambrian. They are known to extend from the north side of Skiddaw to Horton in Ribblesdale, a distance of about 50 miles, and from Egremont in West Cumberland to the west foot of Ousby Fell in East Cumberland, which is about 49 miles. They therefore are known to cover an area of about 2,450 miles. How much beyond that area they extend is not known. In much of the area indicated the slates are concealed by younger rocks, as will be seen from Fig. 1. In the main visible area they are much plicated, the principal axes being shown on Fig. 1. The most important fold, in all probability, extended to and beyond the Isle of Man, for in the Cambrian rocks of that island is an anticline which has the same bearing as *o,p*, in the Skiddaw slate area, and is moreover practically in line with it. The rocks of probable Cambrian age occur along that line in the neighbourhood of Loweswater and Grassmoor. The whole of the Skiddaw slates have undergone several important upward and downward movements; there is evidence of at least two having occurred since the Carboniferous era.

The initiation of the folds just alluded to was doubtless due to compression, induced by subsidence some time prior to the formation of the succeeding Volcanic rocks of Borrowdale, for those rocks are not affected in any way by the folds.

The Borrowdale rocks were said by the late Mr. Clifton Ward, of the Geological Survey, to be interstratified at the base by Skiddaw slate, but he does not show the alternations on his map, and I have not been able to find them on the ground. Seeing that the boundary of the Skiddaw slates, adjoining, is everywhere, according to Mr. Ward's map, a faulted boundary, I cannot imagine how the alleged alternations were ascertained.

The Volcanic rocks seem to have been deposited on a severely denuded surface of the Skiddaw slates at a time when the latter were standing above sea-level. North of Skiddaw the Volcanic rocks strike across the folds of the slates and are unaffected by those folds. South of Skiddaw they also rest on different horizons of the slates, but the strikes of the two formations are less divergent than on the north. The ashes and lavas seem to have emerged from several centres. Over what area they extended is not at all clear. They are seen in Teesdale, at a point about $2\frac{3}{4}$ miles S.E. of Ousby Fell, over a small area from which the Carboniferous rocks have been removed. Their most southerly point of occurrence is near High Haume in Furness. Whether they ever extended much farther south is doubtful, for reasons which will be given later on in this article. I am disposed to think there were mountainous areas of Skiddaw slates, both in the northern part of the district, and where Black Comb now is, at the time the Borrowdale rocks were formed;

FIG. 1. A—Permian and Triassic; B—Carboniferous Limestone and Yoredales; C—Basement Conglomerate; D—Kirkby Moor Flags and Bannisdale Slates; E—Coniston Grits and Flags; F—Coniston Limestone; G—Borrowdale Volcanic Rocks; H—Skiddaw Slates; I—Ennerdale Syenite; J – Eskdale Granite; K—Shap Granite. Anticlinal Axes marked by dot and dash lines.

that the lavas and ashes were laid around those mountains and to some extent over them, the quaqua-versal dip of the Volcanic rocks adjoining the slates being due to one or more subsequent upheavals having maxima within their respective areas. It is very improbable that a rock like the Skiddaw slate at Black Comb, having a fairly regular dip and showing little plication, could have been pushed up through a great thickness of overlying strata, Black Comb being nearly at the full dip of the Borrowdale rocks. It is possible, however, that those rocks are thinning off in that direction, in which case their displacement would be more easily accomplished.

The Coniston Limestone and its accompanying beds were laid down on a more or less irregular surface of the Borrowdale rocks and were followed conformably by the Coniston grits and flags, the Bannisdale slates, and the Kirkby Moor flags, but there is not anything to show they ever spread over the whole of the Volcanic rocks or the Skiddaw slates.

All these later formations, as well as the Borrowdale series, were more or less folded before the Carboniferous rocks were formed, most of the folds being approximately parallel to the older folds in the Skiddaw slates, already referred to (see Fig. 1). The Coniston limestone rests on the Skiddaw slates near

High Haume in Furness, but not nearly to the extent shown on the map of the Geological Survey. The same association of rocks is found near Horton in Ribblesdale, about 30 miles due east of High Haume, so that it is improbable the Borrowdale rocks extended farther south than a line through Furness Abbey and Sedbergh.

Other folds, in the Upper Silurians, occur in the eastern part of the area occupied by those rocks. They have a different direction from the folds just mentioned, their anticlinal axes being indicated by lines *q,r*, and *s,t*. These also are of pre-Carboniferous age, as shown by the fact that an outlier of Basement Conglomerate and Carboniferous Limestone rests partly on the Coniston grits (see Fig. 2). The anticlinal fault at High Haume, referred to in the article on the "Lateral Distribution of Metallic Minerals" in the Magazine for May last, existed in pre-Carboniferous days, as shown by the uplifting of the neighbouring Coniston and Borrowdale rocks (Fig. 1), but it has had one, or perhaps more, differential movements in post-Carboniferous times.

All the Silurian and Cambrian rocks shown in Fig. 1 stood above sea-level during the Devonian era, and were consequently subjected to severe denudation, by which Devonian strata were formed in adjoining areas now covered by Carboniferous, Permian, and Triassic rocks.

The contour of the country at the dawn of the Carboniferous era can be determined only approximately now, but I think there is sufficient evidence to show that the idea of the late Mr. J. G. Goodchild, of the Geological Survey, as to the spreading of the Carboniferous and later rocks over the entire Lake District is not well founded.

In "Notes on Some of the Limestones of Cumberland and Westmorland," printed in the Transactions of the Cumberland and Westmorland Association for the Advancement of Literature and Science, No. xvi, 1890-91, p. 131, endeavouring to show that the Carboniferous Limestone now lying around the Silurians of the Lake District could not have been deposited in a sea surrounding an island, as the water would be more or less muddy, Mr. Goodchild writes: "The greater part of the available evidence points to the area now represented by the Lake District having been, not an island, as many have concluded without studying the evidence, but an area that remained submerged from an early date, and for a long period beneath *clear* water. . . . We have then to picture to ourselves the present Lake District as a submerged area, nearly flat in shape and slowly becoming buried beneath a pile of wedges of pure Limestone."

In a paper on the "Penrith Sandstone" in the above-named Transactions, No. ix, 1883-84, p. 37, Mr. Goodchild writes: "There is another reason for believing that the Lake District mountains do not represent a great fossil island re-exposed by denudation. In no case that has come under my notice does the dip, or present inclination, of the New Red fall short of the amount of inclination of the surface that rises from beneath it in the direction of the Lake District. The angle of the dip denotes the degree of tilting the rocks have undergone since they were laid down."

It will be more convenient if the latter of these two quotations be dealt with first. Mr. Goodchild clearly assumed that the beds of sandstone, shale, and limestone, such as he was dealing with, were deposited in approximately level beds. But that would rarely if ever be so. The nearest to it would be when deposition took place on a level bottom of sea or lake. But how rarely does that happen? In most cases the dip of the rocks would follow in a large degree that of the inclined surface on which the deposits were formed. Usually the sea becomes deeper as we recede from the shore, the slope of the land being more or less continued under the water. As regards sandstones, deposition would in some cases increase the dip, because it would decrease in thickness as the distance from the source increased. An uplift of the Silurian core would increase the inclination of the surrounding Carboniferous, Permian, and Triassic rocks, but it would not account for the whole of it, in some cases perhaps only for a small part of it, so that it is not correct to say, as Mr. Goodchild did, "The angle of the dip denotes the degree of tilting the rocks have undergone since they were laid down."

I have shown in "The Carboniferous Rocks of Cumberland and North Lancashire," published in the Transactions of the North of England Institute of Mining and Mechanical Engineers for 1884, that if the tilted plane on which the Carboniferous beds of West Cumberland were deposited be continued inward toward the Lake District mountains it would not nearly pass over their summits. The same thing can be shown to hold good in Westmorland and also in that part of East Cumberland where Mr. Goodchild worked so long. Further, the occurrence of a rounded boulder of Ennerdale syenite (granophyre) in the shale between the 4th and 5th Limestones, at Crossfield mines, is proof that when that shale-bed was formed

FIG. 2. A—Kirkby Moor Flags; B—Bannisdale Slates; C—Coniston Grits; D—Carboniferous Limestone; E—Basement Conglomerates; a—Whitebrow; b—Whinfell Beacon; c—Grayrigg Forest; d—Agnesgill; e—Whinhowe; f—Tebay Junction; g—Skelmsmergh Hall; h—Cold Harbour; i—Lambrigg Fell; j—Killington. Figures are heights above Ordnance Datum.

the ground occupied by the syenite, or some of it, was above water.

If we draw a contour line at 700 ft. above sea-level on that part of a map of Westmorland east of Kendal, as shown in Fig. 2, some interesting facts are revealed. From that line, and the other altitudes marked on Fig. 2, we see that several isolated patches of Basement Conglomerate lie at or near the foot of steeply rising ground, a fact which is very suggestive, for the Conglomerate is surely a shore deposit. The areas of the two patches of Basement beds at Barbon and Sedbergh are interfered with by faulting, so they may be left out of the argument. But the three separate patches, as shown in Fig. 2, at Plumgarths, Skelsmergh Hall, and Whinhowe are not so interfered with. Fig. 3 is a section between Lambrigg Fell and Whinfell Beacon. Fig. 4 is a section from Grayrigg Forest to Cold Harbour, 2 miles west of Kendal. The inclination of the Basement beds along the latter line (Fig. 4) is about 1 in 200, that of the hillside between Whinhowe and Grayrigg Forest about 1 in 6. On the line of Fig. 3 the Basement beds, being in the bottom of the valley, have very little inclination, but the hillside rising to Whinfell Beacon has a slope of about

1 in 3.4. Similar differences exist on the eastern slope of the high ground north of Whinfell Beacon at Whitebrow and east of that hill, about 2 miles N.W. of Tebay Railway Junction.

The Basement Conglomerate at Whinhowe probably never extended much farther toward Whinfell Beacon than it does to-day, but the fact that at Agnesgill, about a mile to the northwest of Whinhowe, and also at Edgebank, on the Skelsmergh Hall patch, the limestone overlaps the Basement Conglomerate indicates a comparatively rapid lowering of the land after the Conglomerate was laid down. What thickness of limestone followed we do not know. But we do know that in Furness the thickness of the Carboniferous Limestone is about 1,200 ft. The strike of the Silurian rocks is such that at Killington, about a mile S.W. of Sedbergh, we should expect the limestone originally to have been about as thick as in Furness. It is known that the limestone becomes thinner toward the north at the rate of about 36 ft. per mile. Agnesgill being about 7 miles north of Killington, the thickness there originally would not be more than about 950 ft. That is to say, the top of it would be about level with Whinfell Beacon now. On the top of the Limestone, the Yoredales would follow. The greatest proved thickness—which is probably the full thickness—of the latter rocks in Furness is about 1,400 ft. Their attenuation northward is about the same as that of the Limestone. If we estimate the thickness of those rocks in the same way as the thickness of the Limestone was reached it would probably not exceed 1,150 ft. at Agnesgill. The Limestone formation and the Yoredales would, therefore, together have a thickness of about 2,100 ft., that is to say, they would have overtopped Whinfell Beacon as it stands to-day by about 1,150 ft. But the rocks out of which Whinfell Beacon was formed, like the Yoredales and the Carboniferous Limestone over Agnesgill, would be subjected to denudation, and during the time the Carboniferous formations were being removed at Agnesgill the Silurians over Whinfell Beacon might be lowered 1,600 ft. or 1,800 ft. or more, so that at the close of the Yoredale period they would stand above the top of the Carboniferous rocks then deposited 600 or 700 ft. or more, and there is much higher ground in the neighbourhood. The top of the Limestone, as stated above, would be about on the level of the present summit of Whinfell Beacon, but while 900 ft. of Limestone, resting on the site of Agnesgill, was being removed in one way or another, probably a much greater thickness of Bannisdale slates and Coniston grits were cleared off above what is now Whinfell Beacon, so that at the dawn of the Yoredale period the summit of the slates and grits would be much more above the Limestone than the top of Whinfell Beacon is above Agnesgill.

These facts and inferences, as well as those mentioned in the paper on the Carboniferous rocks of Cumberland and North Lancashire, are, I submit, sufficient to show that the Carboniferous Limestone series did not cover the whole of the Lake country as Mr. Goodchild contended. Doubtless it extended inland, in many places, beyond where we see it to-day, as is partly shown by the outliers above alluded to, but that is as much as the evidence justifies us in saying. However, I think it is probable that at the close of the Yoredale period an island nearly 20 miles across existed in a position more or less coincident with the present area of the lower Silurians. The unequal elevations that have taken place in different parts of the Silurian area defeat the object of carrying the 700 ft. contour—or any other—over the whole district.

How the Carboniferous Limestone series came to be so differently developed as it is on different sides of the Lake country is a question involving a considerable amount of speculation in any attempt to answer it. The following tabular statement gives the approximate thickness of the rocks occurring in three different areas:

		East Cumberland		West Cumberland		Furness	
			a		b		c
		feet	feet	feet	feet	feet	feet
Yoredales	Limestone	183		390		100	
	Argillaceous and arenaceous beds	705	888	87	477	1,300	1,400
Carboniferous Limestone	Limestone	420		180		1,200	
	Argillaceous and arenaceous beds	200	620	24	204	720	1,920
		1,508		681		3,320	

Fig. 5 shows the thicknesses in columns *a*, *b*, *c*, of the preceding table, plotted to a natural scale. There is less Limestone in West Cumberland than in East Cumberland or Furness. But the proportion of Limestone to the argillaceous and arenaceous beds (chiefly the former) is much greater in West Cumberland than at either of the other places, being 5 to 1 in West Cumberland, 0·66 to 1 in East Cumberland, and 0·64 to 1 in Furness. The argillaceous and arenaceous beds, which on numerous horizons split up the Limestones, seem to have been borne in a south-easterly direction from land in the region of the southern uplands of Scotland, the current bearing them being de-

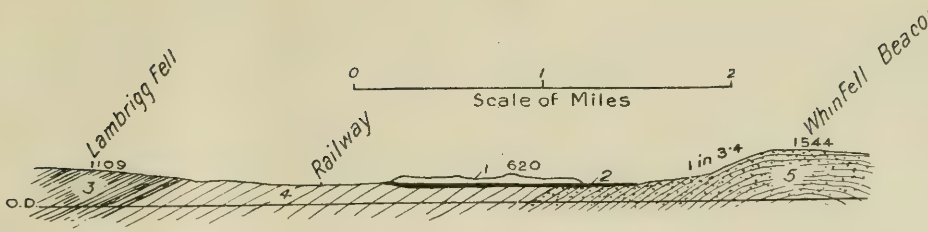


FIG. 3. 1—Carboniferous Limestone ; 2—Basement Conglomerate ; 3—Kirkby Moor Flags ; 4—Bannisdale Slates ; 5—Coniston Grits.

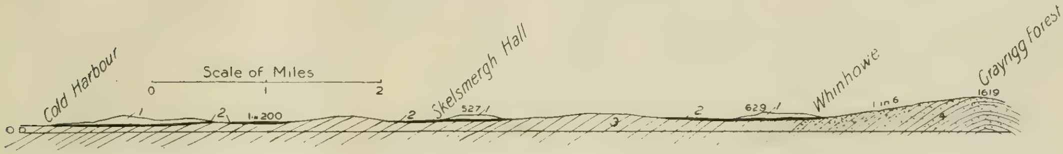


FIG. 4. 1—Carboniferous Limestone ; 2—Basement Conglomerate ; 3—Bannisdale Slates ; 4—Coniston Grits.

FIG. 5. A—Yoredales ; B—Carboniferous Limestone ; C—Basement Conglomerates.

flected, by the small Silurian island, toward Furness on the one hand and toward East Cumberland on the other. That current would probably be confined to the upper and warmer water, the lower and colder layers being comparatively clear. The intermittent deposits of shaley matter might be due to changes in the direction of the current or to the further elevation of land toward the N.W. that had been previously worn down to near sea-level.

The amount of detrital matter passing into the sea from the small island would not interfere with the formation of limestone in the deeper water. The streams flowing from the island would be small. The fine muddy matter would be borne away, southward and eastward, by the deflected current. The coast would be rocky. There would not be any incoherent glacial deposits to make the water muddy. Moreover, the Volcanic rocks at that time would cover more of the Skiddaw slates than they do to-day, and, being harder than the latter, would offer much more resistance to the denuding forces. The Carboniferous rocks being deposited in a more or less inland sea, there would be little or no tide.

Having shown in the "Formation of Coal," published by the Canadian Mining Institute in 1919, that the whole of the Carboniferous rocks were laid down in basins, it is unnecessary to extend the foregoing argument, as to the Limestone, to the Millstone Grit and Coal Measures.

If the Carboniferous rocks did not spread over the whole of the Lake country, still less is it likely that the Red Rocks did, for they lie at a less angle than the Carboniferous rocks. There is only one part of the district where a suggestion even of such an occurrence is to be seen. That is along the west coast from Hale to Silecroft. There the Red Rocks overlap the Carboniferous Limestone, but the latter is at such a great depth that there is no probability of its having overspread the Silurians. Therefore much less probable is it that the Red Rocks ever did so.

Let us now see what is the bearing of these conclusions on the genesis of the hematite deposits. We know that that ore occurs in the Carboniferous Limestone in various forms. It also occurs as veins in the Skiddaw slates, the Borrowdale rocks, the Ennerdale granophyre, the Eskdale granite, and as an irregular deposit in the Coniston Limestone. From whatever source the ore came, I think it will be generally admitted that the veins in the Silurians were formed at the same time and from the same source as the larger and more varied deposits in the Carboniferous Limestone. If they were formed by downward filtration from the Red Rocks it is necessary that those rocks should have overspread the whole of the Silurians, but, I submit, the foregoing considerations are sufficient to show that they never did so. Therefore the hematite in the Silurians did not come from the Red Rocks. To say that the Limestone deposits were formed by downward filtration from those rocks is to say that the ore in the Silurians and that in the Carboniferous Limestone came from two different sources. There is not a fragment of evidence for such a conclusion.

Apart from the above argument I have already shown in previous writings that the ore is older than the Red Rocks. As the evidence on which that conclusion is based has never been fully described, and, so far as I know, has not been seen, in that connection, by anyone but myself, and is now completely destroyed, it may perhaps be useful if a brief account of it be given here. Pebbles of hematite are known by some observers to occur in the Permian Breccia in several parts of the district. One or two of these observers, who knew the district well, were of opinion that the pebbles proved the hematite deposits to be older than the Breccia. Being in possession of other evidence as well, of a similar but more conclusive kind, I agreed with them.

J. G. Goodchild suggested that certain pebbles of hematite which he had found in the Brockram of Eden Valley might have been produced by the replacement of limestone in the Brockram, and he extended the suggestion to West Cumberland, with which he was only slightly acquainted. If he had seen the evidence as it existed 40 years ago in the Whitehaven mining district I am satisfied he would have abandoned his suggestion.

The Breccia in the Whitehaven hematite district, north of Bigrigg, rests on either the Lower Coal Measures or the Millstone Grit. South of Bigrigg it rests mostly on Limestone. The most important section of the latter kind was near Orebank House, Bigrigg, where the Breccia was laid on the Carboniferous Limestone and an included deposit of hematite. That deposit was worked in such a way that the contact of the Breccia and hematite and the ground for several feet above and below it could be clearly seen. The hematite in the Breccia there occurred as angular fragments, of various sizes. In all other places it was as more or less rounded pebbles, in some cases smoothed and occasionally striated.

In the distribution of rock fragments it is invariably found that the farther the fragments have travelled the more they are rounded, and as a consequence the less they have become. Nearer the source the more angular they are. As the hematite deposits occur in one or other of the limestones it is clear that the pebbles in the Breccia overlying the Lower Coal Measures and the Millstone Grit must have travelled some distance. Fig. 6 is a section of the ore-deposit near Orebank House as I saw it over 40 years ago.

Hematite and limestone fragments were quite common within 2 or 3 ft. of the main body of ore. They were all angular and some of them as much as 18 in. in length. Pieces of pure limestone were lying alongside, and in some cases partly overlying pieces of pure ore.

In seeking to explain the occurrence of these angular fragments of hematite by downward filtration, a number of difficulties are created that do not exist if the story of the section in Fig. 6. be read in the usual way. It may be asked, for example, why, on the downward filtration hypothesis, the numerous fragments

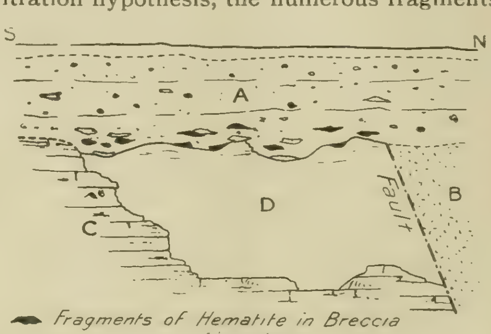


Fig. 6. A—Permian Breccia; B—Millstone Grit; C—Carboniferous Limestone; D—Hematite Deposit.

of limestone in the Breccia were not replaced by hematite. It cannot be said there was an insufficiency of solution, for the main body of ore lies below. Nor can it be said they were not in the path of the descending solution, for some of them were actually lying, in part, on pieces of hematite. The angular form of the fragments is a clear indication that they have not travelled far, and the obvious conclusion is that these pieces of hematite were derived from the underlying ore-body and the pieces of limestone from the mass of that rock enclosing the ore-body.

When glacial deposits overlie ore-bodies we often find similar occurrences. Pieces of ore are then mixed with the Boulder Clay and masses of the latter, or boulders from it, are buried in the ore.

Further, it has never been stated, so far as I know, what was the chemical nature of the solution by which the iron ore is supposed to have been leached from the Red Rocks. There is not the slightest evidence that the iron in these hematites ever existed as carbonate. In the Bilbao and Algerian deposits, as well as in those of the south of Spain, there is ample evidence that the hematites and limonites of those regions were preceded by siderite.

EXTRACTION OF TIN FROM ORES

By JEROME J. COLLINS.

The author discusses losses in tin-dressing, and describes his proposed process for reducing tin oxide in ores to metallic form and extracting it as chloride by the action of dry chlorine, the resulting chloride to be treated with zinc or electrolysed for tin, or sold as tin salts.

THE method of extraction of tin from tin ores in operation at present consists entirely of mechanical concentration followed by smelting. The main features of the process are as follows: (1) Preliminary crushing in stamp-mills; (2) Dewatering of the wet pulp; (3) Sizing or hydraulic classification; (4) Concentration of the classified pulp; (5) Roasting concentrates; (6) Re-concentration of roasted product; (7) Smelting of final concentrate for the separation of metallic tin. Generally the first six operations are carried out at the mine, and the final concentrate, which contains from 60 to 70% of tin, is sold to smelters at the market price of the tin content at the time of sale, less a returning charge which varies from £30 to £60 per ton of metal.

The average recovery of tin from tin ores in Cornwall is said to be 65%, so that where the sales of tin concentrates for one year amounted to £800,000, it follows that the value of the tin lost in treatment would be £430,000. Most stages of the process of mechanical concentration contribute to this loss.

In the first stage of preliminary wet crushing the degree of fineness to which the ore is reduced depends on the condition in which the tin exists. Where the tin oxide is in a finely divided state, it necessitates fine crushing to pass a 30 to 40 mesh screen or even finer; but where the tin oxide is in coarse particles, 5 to 8 mesh would suffice. In either case, however, it is certain that some portion of the tin oxide will not be entirely separated from the gangue, and it will be found that there are plenty of particles consisting of tin oxide attached to gangue. Where the tin oxide forms the larger proportion of the particle, this will be recovered by concentration, but where the tin oxide forms the lesser proportion, this will invariably be lost. Where the particle consists of tin oxide and gangue in the same ratio as the original ore, say $1\frac{1}{2}$ to 2% of tin oxide, the difference in specific gravity would be so little more than the general gangue that it would not be possible for it to separate out with the concentrate. I think this may account for a large proportion of the loss. Take a particle consisting of 10% tin oxide and 90% gangue, which would be a concentration of five to one on the original ore at 2%, and taking the specific gravity of the gangue at 2·65, and that of tin oxide at 6·25, the specific gravity of the particle would be 3·0, so that there is too small an increase in the specific gravity to be of service in the concentration stage to separate this particle from the gangue. This particle and others containing a lesser proportion of tin oxide start at the beginning of the process with little or no hope of being recovered. At first sight it would appear that finer grinding would overcome the difficulty, but this slimes the tin oxide with attendant difficulties of recovery.

In the second stage of the process, the large bulk of water used in crushing the ore has to be separated from the pulp, and this is generally done in dewatering boxes of the spitzkasten type. More or less clear water overflows at the top of the box, and the thickened pulp flows out at the bottom. It has been proved that the overflow water contains a small quantity of tin oxide, and it has been suggested that this is due to the possibility of the tin existing in the ore in some colloidal form, which when brought into contact with water either actually goes into solution or forms an emulsion with the water, from which it will not separate. I venture to suggest that the presence of tin oxide in what is apparently clear water may be due to the fact that in the process of wet crushing some of the tin oxide is reduced to an impalpable powder which renders it susceptible to the action of water, especially mine water which is slightly acid, and that this converts, a very small proportion, certainly, but at any rate some of the tin oxide into the hydrated oxide, which is a white flocculent substance that only settles on long standing in water. The tin is not entirely in solution, and I do not think ever is entirely in solution, as all weak solutions of tin salts hydrolyse readily in neutral or weak acid solutions, forming either the hydrated oxide, or the oxy salts, depending on the acid radical which attacked the tin.

In the third stage of the process the pulp is simply classified by hydraulic pressure into a series of products according to the size and weight of the particles, the first product being the coarser particles, and the last product being slime, with two or three intermediate products depending on the nature of the ore.

In the fourth stage the products from the previous stage are concentrated separately on various types of mechanical or stationary concentrators, and each product is divided into three parts, the heads or concentrate, the middlings, and tailings. The heads are generally sent direct to the roasting furnace for the elimination of the sulphur and arsenic; the middlings are returned to the head of the table for re-concentration, or they are re-ground and go through the classifiers; and the tailings are either discarded or re-treated by some form of rag-frame or mechanical concentrator. In my experience the accepted practice has been to treat all the pulp twice and finally discard all the tailings after the second treatment, although in some cases tailings are stacked for future treatment.

This fourth stage of the process is the most important, as it is here that the tin oxide is either won or lost. It is at this stage that the pulp is divided into two parts, the concentrate which contains the tin, which is finally recovered, and the tailings, any tin in which is lost. Although in the subsequent treatment of the concentrate some of the tin is lost, by far the largest proportion is lost in the tailings or slimes, as the case may be, that are discarded at this stage.

In the concentration stage of the process, it is possible to recover tin oxide by further concentration of the slimes and tailings, or by regrinding the coarser particles and re concentration, but the economic limit is soon reached when the value of the tin oxide recovered will not cover the cost of re-treatment. I have no doubt that this re-concentration could be carried out a dozen times and tin oxide recovered each time. In fact this does actually happen in Cornwall, where the mines after two or three treatments discharge their tailings and slimes into the Red River. These are re-concentrated by the river itself, and the tin streamers at intervals skim off the concentrate and re-treat it, recovering a low-grade tin oxide. There are several of these works between the mines and the sea, and they all get tin oxide. Finally the tailings are washed out to sea, where there is a further concentration by the sea, which washes the tailings up on the beach, and this is skimmed and tin oxide recovered.

The final treatment of the concentrate depends on impurities contained in it.

For a number of years experiments have been carried out in Cornwall and elsewhere with a view to eliminating water-concentration and substituting oil-flotation concentration. I am told that a big advance has been made recently in the application of this method, but I do not know if any definite results have been obtained when working on a commercial scale. The successful application of this process should improve the recovery of tin, but it does not get at the root of the trouble. The root of the trouble appears to me to be that in crushing the original ore some of the tin oxide remains attached to the gangue and is lost, while some is reduced to such a fine state of division that it remains in suspension in water and is carried away with the slimes. If a piece of cassiterite is taken and roughly hammered so that the whole of it passes a 20 mesh screen, it will be found that some of the tin oxide will be in coarse particles, and some will be reduced to a very fine state of division, which will settle in water only with difficulty. It appears to me that this is what happens in the stamp-mill. Now if this crushed tin oxide is mixed with fifty times its weight of rock crushed to the same degree of fineness, it will be found that the coarse particles will be difficult to lose, but that the fine tin oxide will never be completely recovered by water-concentration. This happens in the treatment of tin ore. The "crop" tin almost recovers itself, but the whole of the fine tin is never recovered, and there is a further loss in tin oxide which is not completely separated from the gangue by crushing.

Every effort has been made, especially in recent years, with tin at a high price, to improve the mechanical appliances used in concentrating tin ores, but all the time it has been felt by those engaged in this work that it was an impossibility to recover more than two-thirds to three-quarters of the tin oxide content of the ore by mechanical concentration.

It is felt that the only hope lies in either the improved application of the oil-flotation concentration or the adoption of some chemical method of extraction by attacking the tin oxide with chemicals and removing the tin by getting it into solution. With regard to the first method, I have no personal knowledge of the advances made, but I have no doubt that as soon as any definite results are obtained, those interested in the metallurgy of tin will have an opportunity of judging the results.

During the past two years I have been experimenting on a chemical process for the extraction of tin from tin ores, and from these experiments I have evolved a process which I will describe.

The great difficulty in arriving at a method of extracting the tin from ores is the fact that tin oxide is an inert compound closely resembling silica. It is practically insoluble in most acids, so that before there is any possibility of getting the tin into solution the tin oxide must be first reduced to metal.

The process is briefly as follows. The ore as mined, containing from ½% to 5% of tin, is first crushed in a rock-crusher and finally ground dry in a Hardinge type ball-mill. The degree of fineness will depend on the nature of the tin oxide, but it has only to be ground fine enough to ensure that the particles of tin oxide are exposed. It is not essential that the tin oxide is separated from the gangue; it is only necessary that a part of each particle shall be exposed. In cases where the tin oxide occurs in coarse particles, 5 to 8 mesh will suffice, but where the particles of tin oxide are surrounded, as is commonly the case, with iron and arsenical pyrites and such-like impurities, the degree of fineness will have to be 30 mesh or finer. No hard and fast rule can be laid down, and each variety of ore will have to be examined and treated on its own merits. This applies in the same way to any process, especially the cyanide process for the extraction of gold. In South Africa the ore is ground to a slime to pass a 200 mesh screen, while in Sarawak until recent years the gold ore was treated with cyanide solution direct from the crusher, 2 in. mesh and over.

The dry pulp in my process is first roasted in an ordinary roasting furnace, such as the Merton multiple-hearth mechanically-rabbled type. The first two hearths are as in the standard furnace, and in these hearths the sulphur and arsenic are oxidized and volatilized. It is an advantage to get the ore as free from sulphur and arsenic as possible. The third and fourth hearths are reducing hearths, muffled so that the combustible gases used for heating the furnace are burnt in a separate chamber, but with only a thin fireclay partition between the combustion chambers and the hearths so as not to offer too great a resistance to the passage of heat required in the hearth. All air is excluded from the reducing hearths, and the inlets and outlets are luted with the ore itself. To ensure that no air can enter the reducing hearths, the gas used for the purpose of reduction of the tin oxide to metal is under slight pressure; thus should any of the openings become free, the reducing gas will burn at the opening and prevent any air entering the hearths.

I propose firing the furnace and performing the reduction with producer gas generated in an independent producer, although ordinary coal gas is equally suitable for this purpose. The cost, however, is greatly in favour of producer gas. After leaving the reducing hearths, the ore passes into a cooling hearth, still in a reducing atmosphere, and is gradually cooled to atmospheric temperature. I estimate the time necessary for this operation to be four hours on the oxidizing hearths at a temperature from atmospheric to 600° C.; four hours on the reducing hearths at a temperature from 600° to 750° C.; and four hours on the cooling hearth; the final cooling will be done in a water-jacketed vessel and the temperature reduced to atmospheric temperature.

On leaving the cooling hearth the whole of the tin oxide will, within practicable limits, have been reduced to metal. This metal will be distributed throughout the gangue in small particles. If it is cooled in a reducing atmosphere, there is no danger of the reverse reaction setting in. Any moisture or oxygen present at a temperature of 750° C. would re-convert the metallic tin to tin oxide.

The reaction vessel is a water-cooled enclosed trough with an endless scraper conveyor, and the reduced ore is dragged in a thin layer through the vessel in contact with dry gaseous chlorine, which is obtained by the direct expansion of liquid chlorine. By this means the whole of the metallic tin is converted to anhydrous stannic chloride at atmospheric temperature. Care must be taken that no moisture comes in contact with the stannic chloride; otherwise hydrated stannic chloride is formed, which would attack the iron reaction-vessel.

The length of time necessary for the ore to be in contact with the chlorine for the conversion of the tin to stannic chloride will depend on the amount of tin to be converted, but with average ores this should not be more than two hours, as the reaction is violent. The mass of ore will then contain the tin in the form of anhydrous stannic chloride, which is a liquid at ordinary temperatures. The mass is then drawn off from the reaction-vessel, and heated to about 120° C.; the tin chloride is thus boiled off from the mass, the boiling point of stannic chloride being 113° C., or slightly above the boiling point of water. The vapourized stannic chloride can be condensed or absorbed in water.

The reaction between the chlorine and the tin is selective at ordinary temperature, the only other elements attacked by chlorine at atmospheric temperature being sulphur, arsenic, antimony, aluminium, and magnesium. Any sulphur, arsenic, or antimony that may have been present in the ore would be removed by the oxidizing roast, and it is impossible for either aluminium or magnesium to be present in metallic form. The product, therefore, will be pure stannic chloride. The treatment of the stannic chloride for the recovery of the tin in the metallic form can be done in several ways, but the method that commends itself is by the replacement of the tin by zinc, forming metallic tin and zinc chloride; or the tin can be recovered by electrolysis and the chlorine also.

The advantages of the process are: (1) That being a chemical process it is possible within practical and economic limits to obtain the complete extraction of tin from tin ore; (2) That by recovering the tin as metallic tin it saves the costly returning charges; (3) The mine-owner will be in a position to dispose of his product on the open market. The tin resulting from the process, being standard tin or better, will be good delivery on the open market, whereas at present the mine-owner has only a limited market. The tin smelters only are in a position to purchase tin concentrate, and owing to the increased cost of fuel and the difficulties met with in extracting a pure tin from the average tin concentrate derived from lode tin mines, the mine-owner has to pay in the form of returning charges from £30 to £60 per ton of metal. The process may present many difficulties, but there are few if any that cannot be overcome by serious and intelligent application. The process is rendered possible by the fact that owing to the war there are now large plants in many parts of the world for the manufacture of liquid chlorine, so that the price of the product is now within practicable limits, the cost being £37 to £40 per ton.

NEWS LETTERS.

VANCOUVER, B.C.

September 29.

RAILWAY RATES.—One of the most far-reaching news items of the month and one that affects all industries, particularly in the West, is the granting by the Canadian Railway Commission of a 35% increase in freight rates in British Columbia and a 40% increase in the rest of Canada. At the large majority of the mines in British Columbia in the past the ores have been sufficiently rich to ship directly to the smelter without any form of preliminary treatment other than hand-sorting. Many of these mines, however, have been working on a pretty slim margin, and are wholly unable to stand the increase in freight rates. They, consequently, are faced with the alternative of erecting dressing plants or closing down. Many have not the working capital for the former, so will be forced to accept the latter alternative. The bigger concerns, especially those on the coast, will find a way out of the difficulty. The Granby Consolidated, for example, already has made arrangements with the Canadian Dollar Steamship Co. to transport its blister-copper from Anyox, B.C., where it is produced, to Long Island, New York, where it is refined, by way of the Panama Canal, and the manager states that the cost of transportation will be reduced to nearly half that of rail, and that the metal will occupy 15 days less in transit. In future, practically all the coast mines will ship their product either to Anyox or to Tacoma, according to the nature of the ore, and in this way will cut out the rail haul to Trail.

THE YUKON.—The summer season in the Yukon is nearing its close. The last boat from Dawson to Fairbanks left the former place on September 26. The season has been an unusually dry one, accompanied by a number of big forest fires and a scarcity of water. Thus it has been impossible to wash much of the ground that has been mined, and the season's output will suffer considerably. The gold output will be substantially less than that of last year. A new discovery that is said to be important is reported from Chandalar, north of Fort Yukon, details of which, however, are not yet to hand. A Government road is being built to the camp. The Fortymile Power & Dredging Co. has done a great deal of development work on Dennison Fork, but has been unable to wash its ground from lack of water. The company will continue development through the winter, and by next spring expects to have sufficient ground blocked out to keep one or two dredges in operation for some time. A wireless plant is being erected at Fortymile, which will keep the place in touch with the outside world.

There has been considerable activity at the new silver camp, at Mayo, on the Stewart river, about 140 miles south of Dawson. O. B. Perry, general manager of the Yukon Gold Mining Co., who has just arrived from there, states that the Guggenheim interests will spend about half a million dollars in development and equipment during the coming winter. Among other improvements, a concentrating plant is to be erected. At the present time the company has a tractor hauling ore from Mayo to Mayo Landing, and it is expected that this ore, which is high-grade, will be taken to the seaboard and thence to Tacoma before navigation closes. The Yukon Silver-Lead Mining Co. has decided to put in a concentrating plant. Although nearly all the ore in this camp is of high grade, generally running upward of $200 to the ton, the roads are so bad and the cost of transportation so great that concentration of the ore becomes necessary.

British Columbia Silver.—A large amount of exploration has been done in the new silver district in the northwestern part of British Columbia, and, although there are some exceedingly promising prospects, no new mines have been developed. The two mines that have been the making of the district are both giving a good account of themselves. The Dolly Varden, at Alice Arm, is steadily shipping from 230 to 240 tons daily to Anyox, the ore averaging 37 oz. of silver per ton. These shipments are sweetened by a monthly shipment of about 20 tons to the Tacoma smelter that run well over 1,000 oz. of silver per ton. This ore undoubtedly is secondary, and shows plate and wire silver freely.

The Premier mine, at Salmon river, is preparing for its winter shipping season. Last winter, owing to a strike in the heart of the shipping season, only 1,500 tons of ore, averaging $275 per ton in gold and silver, was shipped, although a considerable amount of lower - grade ore was mined. This winter it is intended to ship not less than double that amount. Horses are now being assembled for the purpose, some 50 already being in the company's stables. Ore shipping is to commence at once in a small way, and continued at full capacity as soon as the snow makes the going good. Work on the new concentrator is progressing slowly, as the difficulty of getting supplies in retards the work, but it is hoped to have the plant in running order early in the new year. The first unit will have a capacity of 100 tons per day, and there is enough ore to keep this plant busy for some time already on the dumps.

Work on the Big Missouri mine, higher up the river than the Premier, has been stopped. This is disappointing, as many engineers hoped that this would be made into a shipping mine. Though no official information has been given out, it is generally supposed that the holders of the option did not find sufficient high-grade ore by the diamond-drilling operations to guarantee taking up the option, and the immense body of low-grade ore that has been demonstrated on the surface offers too many metallurgical difficulties to be attractive in so out-of-the-way a place.

Slocan.—Interest in the Slocan district, which has been on the wane on account of the persistent activities of the One Big Union, which has called strike after strike for no good reason, has been revived by the reopening of the old Payne mine, which has been taken over by the Pacific Mines Development Co., organized for that purpose by Campbell, Wells, & Elmendorf, mining engineers, of Seattle. The property consists of six crown-granted mining-claims, and comprises the claims located in the district. Since its location in 1891, the Payne has produced more than five million dollars' worth of ore, and at a time when both silver and lead were selling at considerably lower prices than at present; and it has paid dividends amounting to $1,438,000. The main ore-shoot, which was stoped from the No. 5 level to the surface, was 1,200 ft. long, with an average width of about six inches, which, however, was practically clear galena, averaging 68% of lead and 120 oz. of silver per ton. Some 50,000 tons of such ore, together with 6,000 tons of zinc ore, was shipped from the mine. Later in the nineties, the mine was acquired by a Montreal company, organized by Clarence J. McQuaig, for $3,000,000. The new company erected a mill at the railway, and connected it with the No. 5 tunnel by a gravity tramway. After some 180,000 tons of lower-grade ore that had been left in the stopes by the previous company had been milled, the plant was burned in 1902, and soon after the Montreal company ceased operating the mine. In 1902, W. E. Zwicky, who was manager for the Montreal company, organized the Slocan Payne Mines, Ltd., to take a lease and bond of the mine. This company drove a 400 ft. tunnel to cut the ore-body at a depth of 725 ft. below the No. 5 level, but either the vein had faulted or the direction of the tunnel was miscalculated, and considerable cross-cutting had to be done before the vein ultimately was found some 200 ft. wide to the left of where it was expected. By this time funds had become exhausted; the war had started, and it was impossible to raise money for the purpose of continuing work. Added to this the vein at the point of intersection of the cross-cut no longer carried the famous rich streak, and many engineers were sceptical as to whether further exploration would develop it at this depth. The present company, which has leased the property on exceedingly liberal terms, will start exploration work at this point. The terms of the lease and option are: $1,000 cash, as a guarantee of good faith; $20,000 in two years; $30,000 in three years; and the balance of $49,000 in four years. The agreement carries with it the obligation to do not less than $5,000 worth of work each year and to pay 15% on all ore sold, such sums to be deducted from the purchase price.

Oil Exploration.—D. B. Dowling, oil geologist to the Canadian Geological Survey, is authority for the statement that British capitalists, headed by Lord Cowdray, will make a more extended exploration for oil in western Canada than previously has been undertaken, not excepting the work that is now being done by the Imperial Oil Co. During the present summer the Imperial Oil Co. has been doing a large amount of exploration work, its operations extending from the international boundary right up to the Mackenzie river, within the Arctic circle. Some success recently has been achieved north of Great Slave Lake.

ALBERTA COAL.—Once again the One Big Union is fomenting trouble in the Alberta coal mines, a strike being called for October 1. The O.B.U. is endeavouring by this means to overthrow the compulsory United Mine Workers' "check-off," and with negotiations pending between the U.M.W. and the operators to re-open the question of an increase of \$1·50 a day for day-wage men, it seems not unlikely to succeed in bringing about a general strike throughout the province. The Federal Minister of Labour is in Calgary endeavouring to avert such a catastrophe just as the winter is setting in and all the coal that can be mined is needed.

MELBOURNE.

September 1.

BENDIGO AMALGAMATED GOLDFIELDS.—The company's operations during the year ended June 30 resulted in a net profit of £110,881, after providing £8,800 for depreciation of plant, and at the end of the year it paid its first dividend, which amounted to £44,226 (including the Co-operative Alliance bonus). During the year the board appropriated out of current ascertained profits the sum of £20,000 to meet expenditure on new plant during the year, and they ask for authority to appropriate such other sum as they may think fit for the purposes of development and new plant during the year now current. The surplus of liquid assets on June 30 was £76,178. In the first three half-years (properly 19 months) the company made successive losses amounting in all to £69,559. The first profit was made in the half-year ended June 30, 1919, and amounted to £2,934; the following half-year yielded £31,250, and the last £79,631, showing that nearly 72% of last year's profit was made in the second half, January to June, 1920. The total profits for the three half-years were, therefore, £113,815, and deducting the £69,559 previously lost, the net profit from the beginning of June, 1917, to the end of June, 1920, was £44,256. What the company owes to the rich Constellation reef is shown by the fact that during the past year the company itself produced from it gold to the value of £146,004, while tributers produced a further £822 from the same workings. Up to the end of August this rich reef continued to yield well, the ore being still worth nearly 2 oz. to the ton. The find recently reported in the Mc Duff shaft has, however, proved disappointing, the value being only a little over 6 dwt. It was at one time thought that this formation was the South New Moon reef, but further work upon it has shown that the supposition was incorrect and that the reef is a new one. It has therefore been named the Constellation. The total prospecting and development work for the year was 19,286 ft., including 689 ft. of boring by shot-drill and 7,373 ft. by diamond-drill. In stoping, 102,194 tons of ore was taken out, including 25,895 tons by tributers; the total gold amounted to 62,057 oz., including tributers' 8,562 oz.; the company's average value was 14·02 dwt. per ton, and that of the tributers 6·61 dwt., the average from all works being 12·14 dwt. per ton. In the previous year 112,977 tons of ore yielded 41,022 oz., or 7·27 dwt. per ton. It will be seen, therefore, that although the ore won during the past year was of considerably higher grade, the quantity produced was considerably less. On this the general manager, Mr. A. Moline, comments: "It was hoped a year ago that the small tonnage then being got could be increased, but, instead of that, although the gold returns have been extremely satisfactory, the output of ore has shown a further reduction. This has had an adverse effect upon costs," which amounted to about 38s. 6d. per ton. Wages and mining supplies of all kinds have been exceedingly high, and the former made up 46% of the whole expenditure of the year. A comparison has been made between the present wages sheet for the whole of the company's work, and the corresponding rates that ruled during the 19 years from 1892 to 1910, when the present company's group of mines were being worked by separate companies. Allowance has been made for the fact that overtime rates, which now average time-and-a-half, were then all paid for at the ordinary rate, and that, prior to 1916, 48 hours a week were worked by all employees, whereas underground employees are now paid 48 hours' wages for 44 hours' work. Taking these factors into consideration, the net result is that the average rate of wage paid during last year represents a 70% increase over the corresponding rate 15 years ago, while at the close of the year the comparison was more adverse, showing an increase of more than 80%. In a tabulated statement of total costs for the two periods (last year and the earlier 19 years) it is shown that wages, fuel, stores, repairs, timber, carting, &c., which in the earlier period averaged £126,356 per annum, cost last year £196,401, an increase of 55·42%. The past year's costs of 38·40 shillings per ton therefore corresponds to 24·74 shillings per ton in the earlier period. Continuing the comparison, Mr. Moline says that the output from the several mines during the period 1892–1910 averaged 8,500 tons per fortnight, whereas the cost figures just mentioned apply to an output of just under 4,000 tons per fortnight. If the necessary raw material should be available following upon a few favourable developments in the mine, the present plant could be adapted to dealing with twice as much ore as is now being handled, with a proportionate reduction in costs per ton.

PROPOSED HYDRO-ELECTRIC SCHEME FOR VICTORIA.—During the past few years proposals have been mooted for utilizing the water-power of the Kiewa River (a tributary of the Murray, in north-east Victoria) for the production of the electric current. At first it was even hoped to secure permits for the supply of electric power from this source to Melbourne itself, but as the Government's scheme for supplying the metropolitan area from the Morwell brown-coal field matured itself with painful slowness, it became evident that the most that could be looked for would be to have a large country area in which to operate. Then there came suggestions from official sources, if not even from ministers themselves, that the State Government might take the whole electric supply business into its own hands, making it a State monopoly. The question was revived last week when a deputation from the National Federation waited upon the Premier, Mr. Lawson, and urged the desirability of carrying out the Kiewa River scheme for the purpose of supplying such important centres as Bendigo, Ballarat, Maryborough, and Geelong with cheap power in order to foster provincial industries and stimulate new ones. Mr. Lawson, in replying, said that the Government fully realized the perilous position in which industries in Victoria were too frequently placed by shortage of coal supplies, and the extent to which manufacturing and other interests were retarded. Realizing these facts, the Government had appointed an Electricity Commission. The brown-coal deposits being ready for development, the Commission was authorized to go ahead. The Commission had also been authorized to investigate the potentialities of water-power, and this inquiry was now proceeding. Instructions were given to the Commission to report fully upon the Kiewa River scheme. It was found that insufficient data were available, and it became necessary to appoint a staff to carry out a thorough investigation. Mr. A. G. M. Mitchell was now collecting the necessary data. The Government had to consider the question of the supply of electric power from both the city and country points of view. He could picture a time when electric power would be in general use for industries, when every farm house would be supplied with electric light, when the threshing-machine and the plough would be driven by electricity, and when the work of the household would be similarly performed. The Government had appointed Lieutenant-General Sir John Monash to manage the scheme, and it intended shortly to appoint a commission on the lines of the Melbourne Harbour Trust. Mr. Lawson gave no encouragement to the hopes of private companies which are anxious to undertake the Kiewa River scheme.

ANGLO-PERSIAN OIL REFINERY.—The Prime Minister announced last week that the Anglo-Persian Oil Company had taken the necessary steps to form and register the refinery company, which would be known as the Commonwealth Oil Refineries, Ltd. One condition of the formation of the refinery company is that of the total number of directors three-sevenths should be nominated by and represent the Commonwealth. At the present stage it is not considered advisable to make arrangements of a permanent character for the representation of the Commonwealth, and the Government has therefore appointed its three directors to act in a temporary capacity, pending final arrangements. These are Sir Robert Garran, the Federal Solicitor-General; Mr. N. C. Lockyer, and Mr. Robert Gibson. It is understood that the Anglo-Persian Oil Company will be represented on the directorate by Mr. F. H. Bathurst, Professor Payne, Mr. T. J. Greenway, and Mr. W. J. Byrne. When the refinery proposal was first mooted, there was something pathetic in the wail of companies which are patiently searching for petroleum in various parts of Australia, but have so far met with no success; the best that any of them has obtained after several years of boring has been promising indications. Nevertheless their distress was acute, for a time, at the thought that when they did strike oil they would not be allowed the profits upon its refining, but would have to pay the new "foreign" company for doing it. Their fears were promptly dispelled, however, by the announcement of the Anglo-Persian company that it did not seek a monopoly of the refining business, but that any other company wishing to do so could put up its refinery next door to them without arousing enmity. The company's works are expected to be erected at Newcastle (N.S.W.), and it is considered not unlikely that they may occupy a site used some years ago for shale-oil production. If so, the existing buildings and portion of the plant now there may be of service, even if certain alterations have to be made.

TASMANIAN COAL.—The Electrolytic Zinc Company has taken over a coal mine at Port Cygnet, about 30 miles south of Hobart, the intention being to supply the requirements of their own works, and later on to export some of the coal for use in the company's processes on the mainland.

A new coalfield is being developed at Fingal, in north-east Tasmania. The seams are up to 8 ft. thick. Nearly 40 years ago some of this coal was tried on two gunboats, and the engineers reported it to be nearly equal to the best steaming coal from Newcastle, N.S.W. Under the coal-beds there is a thick bed of good fireclay, and trials made of it many years ago in Launceston and Melbourne proved that it was even superior to Stourbridge clay in England. If this is confirmed by later experiments, firebricks, etc., could be easily made on the field near the source of origin. It is stated that the Fingal field presents an undoubted possibility of proving one of the richest and most extensive coalfields in the State. The size of the seams, the extent of the coal-bearing areas, the facility with which the coal can be won, and the nearness of the railway line give the field a unique position for profitable enterprise.

An announcement has been made that representatives of the South Australian Government have been making investigations with the view of that Government taking over the Dalmayne colliery, on the east coast of Tasmania. The company that at present owns this colliery has seen in the shortage of coal in Victoria and South Australia an opportunity for development of its property. A representative of the company called the attention of the South Australian Government to this unworked colliery near the seaboard of Tasmania, containing a 13 ft. seam of useful coal and other seams of smaller size. It was pointed out that as South Australia was not a producer of coal, she should take measures to secure supplies from some other State, and this she could do in Tasmania, where, owing to the presence of the hydro-electric scheme, the people were rapidly becoming independent of coal for power and lighting purposes. The South Australian Government was so impressed with the position put before it that it decided to have an inspection made, and sent over to Tasmania Mr. Lockhart Jack, the Government Geologist, who carefully examined the mine, and was able to examine the 13 ft. seam along the whole of a 600 ft. drive. A practical test was made of the coal on a train from St. Mary's to Conara. Steam was maintained with ease. The lack of a convenient port has been the difficulty hitherto. A jetty was built at Picannini Point a few years ago, but part of it was carried away by a storm. The proposal now is to run a tramway from the mine to Coles Bay, a distance of 33 miles, where there is perfectly sheltered water with a depth of 40 ft., and deep-water approaches. A survey for such a tramway was made by the Survey Department 15 years ago. Steamers that bring roasted ore from South Australia for the Electrolytic Zinc Company could use the coal from this mine and would be provided with back freight.

TORONTO.

October 11.

THE LABOUR SITUATION.—The mining industries of Northern Ontario have been for some time seriously handicapped on account of labour shortage, which is most acutely felt by the gold-mining companies of Porcupine and Kirkland Lake. Early in the season many mine workers left the district, being attracted by the high wages paid by American manufacturers, more especially in the automobile trade, and the mining operators found it necessary to curtail operations. Now, owing to the closing down of many industrial plants in the United States, men are returning in considerable numbers to Northern Ontario, but only a small percentage seek employment at the mines, owing to the high wages offered by the large pulp-mills under construction. The shortage of men in the gold camp is estimated at about 2,000, and at Cobalt the demand for labour is considerably greater than the supply. The problem with which the large employers of labour are confronted is not merely the procuring of adequate numbers, but the training of those offering to do the work, as the greatest shortage is in skilled men. Latterly there has been some improvement in labour conditions, and the hope is entertained that the difficulty will be overcome during the winter.

PORCUPINE.—An interim report issued by

the Hollinger Consolidated, covering the period from January 1 to September 8, shows a net profit of $2,581,373, as compared with $2,408,209 in the corresponding period of 1919. The average number of men employed was 1,070, and the number of tons treated per day was 1,838, as compared with 1,263 men employed and 1,902 tons per day treated. The company has adopted a deep-mining programme, and intends to carry the main central shaft down to the 2,000 ft. level. It has now reached a depth of about 1,700 ft.

The annual report of the McIntyre for the year ended June 30 shows a great improvement in the position of the company, the ore reserves being estimated at 502,682 tons, of the value of $5,595,500, as compared with 433,057 tons valued at $4,777,324 last year. The total extraction was $2,080,178, and the net profits $818,020, as compared with $683,350. The average value of ore treated showed an increase from $9·75 to $11·52 per ton. At the annual meeting, R. J. Ennis, the general manager, stated that exploration on vein No. 7 had disclosed a large ore-body between the 1,375 and 1,600 ft. levels, which was found to contain large quantities of ore yielding $13 to $14 per ton. The shareholders of the McIntyre, as well as those of the Timiskaming of Cobalt, have ratified the agreement for the purchase by these companies of the Blue Diamond and Canadian Collieries coal mines in Alberta. The Blue Diamond is already being operated by the McIntyre with a force of 150 men. The purchase price is $450,000, and the Canadian Collieries is taken over on option with a cash payment of $150,000, the total price being $1,000,000.

The Dome Mines is working at about two-thirds capacity, treating about 1,000 tons of ore daily. It is stated that early estimates of the ore being taken out proved too low, the gold content now averaging some $6 per ton.

Work has been started on the unwatering of the workings of the Vipond-North Thompson, which will be reopened under the supervision of J. B. McArthur, an English mining engineer. Dr. J. Mackintosh Bell has been appointed manager.

The North Crown is carrying out an expensive exploration programme by diamond-drilling at depth, which is expected to have important results. It has been found that the greenstone formation shows a tendency to increase in extent, and that at depth the indications are that much of the porphyry areas showing on the surface will be underlain by greenstone, forming a highly favourable formation for the occurrence of gold. A cross-cut is being run from the main workings toward the Thompson-Krist property. The mill is treating some 75 tons daily, the current output being sufficient to finance exploration and development work.

KIRKLAND LAKE.—The Lake Shore during August extracted $35,261 from the treatment of 1,281 tons of ore, being an average of $27·52 per ton. The total production up to the end of August was $1,011,579. The sinking of the shaft to the 800 ft. level is well under way. Surface exploration on the Granby-Kirkland has been completed and mining operations started. A shaft is being put down on a vein 4½ ft. wide stated to carry gold content running $15 to the ton. Several other well-mineralized veins occur on the surface. The Wright-Hargraves is making good progress with the erection of the mill, which is expected to be completed before the end of the year. The Bidgood has encountered a wide vein in a cross-cut on the 300 ft. level. At the Hunton-Kirkland ore has come into the shaft which is stated to show visible gold. The vein of the Wood-Kirkland at a depth of 50 ft. in the shaft shows a width of about 6 ft. with gold content of $9 per ton. The vein recently encountered on the Kirkland-Porphyry (formerly the Orr) on the 400 ft. level is believed to be an extension of the Lake Shore vein, to which it bears a striking resemblance.

COBALT.—Mine-owners who stored large quantities of their bullion while silver was selling at a low price have recently been making heavy shipments since market conditions improved. Owing to the increased price of cobalt metal, which is selling at $6 per lb., the Cobalt mines are now deriving a considerable revenue from the cobalt content of their silver ore, which was formerly not paid for by the smelters. The smelters at Thorold and Deloro, Ont., are equipped for the recovery of cobalt.

The Nipissing during September mined ore of an estimated value of $225,100, and shipped bullion and residue from Nipissing and custom ores of an estimated net value of $658,296. Operations were considerably curtailed during the month owing to the scarcity of underground labour. At the Kerr Lake three new veins have been found on the surface in the course of making excavations for new equipment, and search is being made for others. Much of the ore ranges between 2,000 and 6,000 oz. per ton. The Crown Reserve is carrying on explorations at depth by diamond-drilling to a point 2,000 ft. below the surface. The object in view is to ascertain whether another diabase sill underlies the present known mineralized area, rendering deeper mining feasible, a point upon which the opinion of geological experts is divided. Four companies, the Mining Corporation of Canada, Coniagas, McKinley-Darragh, and Dominion Reduction, are now treating sands and slimes by the oil-flotation process. The Mining Corporation is treating about 10,000 tons of tailing per month which are taken from Cobalt Lake, the estimated quantity remaining there being over 300,000 tons.

CAMBORNE.

TINCROFT.—The financial difficulties of this company, accentuated by the coal strike, necessitated notice being given to the employees, who number some 250. It has been a struggle to keep going for a considerable time, but some of the directors have guaranteed the merchants in the hope that the price of tin would speedily improve and enable the mine to be worked without loss. Now we have the employees coming forward and offering to contribute a sum of £200 per month, until the present troublous times are past, with a view of avoiding the suspension of operations. This is not the first time that the employees have come to the assistance of Tincroft, for, in 1914, a monetary offer was made to help the company out of its then difficulties. This offer speaks highly for the confidence existing between the directors, the management, and the employees, and is evidence that the spirit of the old mine adventurer has not yet died out in Cornwall. When it is remembered, too, that the earnings of the men are regrettably low, such as to leave little, if any, margin over living expenses, we can well understand that the directors were deeply moved at this striking instance or self-sacrifice. If only the same spirit—the willingness of labour to co-operate with the representatives of capital and management—could be shown in other national industries, what a glorious opportunity there would be to capture the world's markets, to lessen unemployment, and to maintain and perhaps advance the improved conditions of the workers throughout the country. We are glad to hear that the directors have decided to accept the offer of the employees, and make yet one more effort to keep the mine going. Work has therefore been resumed on a full scale.

DOLCOATH.—A week or so since, a further 200 men were discharged from this mine, so that the number of employees has now been reduced to between 300 and 350, which compares with about double that number employed in 1919. Some of the discharged men have been engaged at Dolcoath all their lives, and it must have been a most painful duty for Mr. R. A. Thomas to discharge men with so long a record of faithful service. Recently Messrs. Bewick, Moreing & Co. have been making an inspection of this property, doubtless with a view to influencing the provision of fresh capital. Indeed we understand that shortly the shareholders will be asked to find the money to undertake the lateral exploration of the North and South Roskear setts, which adjoin Dolcoath on the north, with a view to testing the principal lodes in the granite; hitherto lodes in these setts, except to a limited extent in North Roskear, have only been worked in the killas for copper. This appears to be a most promising mining venture, and the shareholders will be well advised to support the directors in their effort to secure for the company a new lease of life.

GRENVILLE.—There seems little prospect of operations being resumed on any scale at this mine; the water is gradually rising and cleaning up is the order of the day. There is some agitation locally that the shareholders should be called together with a view to the provision of further capital, but we understand that the largest holders have already declined to find more money. It is a thousand pities, in view of the ore disclosed in the upper levels, that sufficient money cannot be found for further lateral development, and also to provide a new milling and dressing plant, by which such ore could be treated at a reasonable figure and without unduly high losses. However, a circular has been issued showing that the board has made every effort possible to secure further capital, but, so far, without success; if local shareholders are prepared to find the money, no difficulties would be put in their way.

EAST POOL & AGAR.—The water troubles at Agar shaft have at last been mastered, the broken balance-bob has been repaired, and shortly the development programme will doubtless be in full swing again. At the time of the accident, all the development points were showing most encouraging values. If the price of tin advances, as is anticipated in the near future, then this company should once more be earning handsome profits. The sale of tin at the Tin Ticketing of October 18 led some writers to assume that the management were dissatisfied with the contract method of sale and had decided to return to the old method. This is not the case. The contract had expired, and pending the settlement of a fresh one, the concentrate was temporarily sold at the Ticketing. We understand that a new contract has now been fixed up with the Penpoll Tin

Smelting Co., Ltd.

TIN PRICES CONTROL.—It will be recalled that, in the August issue, we referred to the proposal of Mr. M. T. Taylor to form an organization of producers with a view to controlling tin prices. This matter was sympathetically considered by the Cornish Chamber of Mines, and it was resolved to take action on lines which we then outlined. At a meeting of representatives of the Cornish, Nigerian, and Malayan Chambers of Mines, it was subsequently resolved that such representatives were of opinion "that it is necessary, for the protection of the tin-mining industry, to approach the various Governments of countries in which tin ore is produced with a view to the adoption by legislation of a minimum export price." Subsequently, however, it was decided not to proceed further at present because of the fact that the Council of the Nigerian Chamber of Mines had passed a resolution declining to endorse any recommendation involving Government control or interference with the industry. For our part, we can quite understand and appreciate the attitude of the Nigerian producers.

CHINA-CLAY. — The recent purchase by Messrs. Bewick, Moreing & Co. of the property and assets of the Cornish Kaolin Co., Ltd., marks the entry of that well-known firm into the china-clay industry of the West of England. The property is situated near Bodmin, with drys adjoining Bodmin Road station. The company is already a producer, and has, we understand, great development possibilities. As Tehidy Minerals Ltd. is interested in this purchase and also owns extensive china-clay setts in the Bodmin district, we shall not be surprised to hear of considerable activity in this district in the near future.

The property of the China-Clay Corporation, Ltd., situated on Dartmoor, was recently sold by auction, under an order of the High Court, to Mr. Mallaby-Deeley, M.P., for the sum of £47,000. The China-Clay Corporation, Ltd., has a share capital of £400,000, and the purchase price of the property paid to the vendors only about ten years ago was £90,000, of which £20,000 was paid in cash and the balance in fully-paid shares of the corporation. It is not known what Mr. Mallaby-Deeley intends to do with the property. The opinion as to the value of the property varies widely among local people. On the one hand it is said that the deposits are too patchy, while in other quarters the blame for previous failure is attributed to mistakes in development and arrangement of treatment plant.

LETTERS TO THE EDITOR

Precision of Ideas in Tin Dressing.

The Editor:

Sir—We have read with interest your leaderette on the Looseness of Cornish Terminology in your issue of October, and quite agree with your remarks on this subject. But we think that the mental attitude which underlies the same could be adopted with great benefit in considering the effect generally of similar looseness of terminology in the publication of scientific papers throughout this country. The value of accuracy of expression as an indication of and means to correct thinking is not appreciated as it ought to be. Philologists recognize that the reason why our French neighbours are such brilliant and logical thinkers is the necessity imposed upon them by the demands of their language to express their thoughts with a nicety of phrasing and a fastidious selection of the right word which is in marked contrast with English practice.

Confining ourselves, however, on this subject to the technical matters of our calling, we might draw attention to the reports of the Tin and Tungsten Research Committee, which provide an excellent illustration of lack of clearness and precision in scientific papers. It is perhaps not profitable to demonstrate this by reference to particular passages; we will, therefore, confine ourselves to a point which will appeal to your readers generally, as having apparently more practical importance and not savouring of what will seem to some of them a craving for pedantic accuracy. This point is a confusion which arises through harping continually and solely on the percentage recovery of the metal values in an ore. Much has been said, for instance, of the losses in dressing tin ores, but an idea is always conveyed of these losses by the simple statement of the percentage of the content which is recovered. It is quite evident that this supplies no criterion of the efficiency of the treatment. Take an extreme instance, and suppose that the material to be treated contained only 0·5% of tin metal by chemical assay. In this case a recovery of 50% of the metal content would be considered highly creditable, allowing for the most favourable circumstances to prevail in respect of the amenability to treatment of the material.

Take again an extreme instance in the other direction, and suppose that the material contained 3% of tin metal. In this case, allowing similar circumstances to apply, a comparative recovery should show a return of something over 90% of the content. The principle underlying the presentation of these two statements will be admitted by all familiar with ore treatment, and yet it is current practice to invite criticism, favourable or otherwise, of particular examples of the dressing of tin ore by citing the percentage of the actual tin which is recovered. In fact, the efficiency or inefficiency of Cornish methods of dealing with tin ore is summarized by an expression of this kind. It may be asked at this point, by those who admit all that is stated above, what other convenient method of expressing the efficiency of the treatment in figures should be adopted, and our answer would be the "percentage of tin in the tailings" or a "factor expressing the ratio of the recovery to the original content." In searching for a ratio that is constant in its relationship to the results of efficient practice, we are immediately directed to the minimum value which an ore may contain to admit of an appreciable portion being extracted on the usual mechanical appliances. This minimum stands in the same relationship to ore treatment as a "trace" of a metal stands to an ore assay, and it establishes the maximum which an efficiently treated tailing should contain. The latter is ascertainable by comparison of results over a wide number of cases and might be taken as the determining factor of efficient ore-dressing. It is independent or almost independent of the original content and so is a satisfactory criterion of such treatment.

THE BRITISH MINING & METAL CO., LTD.
J. H. HEAP, *Director*.

Gunnislake, near Tavistock,
October 23.

Wheal Busy Mine.

The Editor:

Sir—Your Camborne correspondent in his notes on the above mine, in the October issue, rightly points out that unwatering will be necessary. But he omits to point out that a very large tonnage of profitable arsenical ore is available, and can be and is being worked, above the 270 ft. level, which is clear of water. This ore will keep the reduction plant fully employed while the necessary unwatering takes place.

E. HOMERSHAM, M.Inst.M.M.

London, October 30.

[Reference is made to Mr. Homersham's letter in the Review of Mining, where additional information is given relating to the prospects of Wheal Busy arsenic mine.—EDITOR.]

PERSONAL

GEORGE RENNIE AIRTH is visiting Trinidad.

H. FOSTER BAIN has concluded his geological work in Yunnan, and has returned to Washington.

C. O. BANNISTER has been appointed professor of metallurgy in Liverpool University.

H. B. BATEMAN has left for Arabia.

C. P. C. BERESFORD has resigned as manager of Prestea Block A, and is going to Bolivia.

VINCENT BRAMALL has been elected president of the Manchester Geological and Mining Society.

P. BURBIDGE has left Gympie and is now with the Mount Elliott company, at Selwyn, Queensland.

J. H. BUTTERS, chief engineer for the Tasmanian State Hydro-Electric Department, who is travelling to England by way of Canada, is expected here at the end of this month.

JAMES CALDWELL, Deputy Chairman of Industrials, Ltd., and technical director of several electric welding concerns, has retired from the firm of James E. Sayers & Caldwell, consulting engineers, Glasgow, as from August last. His address is 14-16, Cockspur Street, and Parliament Mansions, Victoria St., Westminster.

Dr. J. MORROW CAMPBELL has left on his return to Burma.

G. W. CAMPION is expected from West Africa.

W. A. CARLYLE is here from Canada.

W. CLARK, a director of Vickers, Ltd., has been elected Master Cutler at Sheffield for the ensuing year.

THOMAS A. CLARKE has left on his return to Port Sudan.

L. MAURICE COCKERELL has returned from Mexico.

T. W. EDGEWORTH DAVID, professor of geology in the University of Sydney, has been awarded the G.B.E., in recognition of his war services.

S. H. DE LA MARE has left for Khartoum.

V. J. EDWARDS is back from Nigeria

W. H. EPLETT is here from the Federated Malay States.

A. C. GAVED has returned to Nigeria.

P. LYTTELTON GELL has been appointed president of the British South Africa Company.

DONALD GILL has been released from Russia.

STANLEY H. GRAHAM has been appointed professor of mining engineering in the Queen's University, Kingston, Ontario.

CHARLES HOYLE and other members of the staff of the Esperanza company, El Oro, were for a short time prisoners of Zamora, one of the Mexican bandits, during September.

J. P. HUTCHINS is at present resident in Madrid.

J. G. LAWN has joined the board of the Frank Smith Diamond & Exploration Company.

Dr. MALCOLM MACLAREN has been appointed a member of the technical committee of the National Mining Corporation.

T. G. MADGWICK has been appointed assistant professor of petroleum technology in Birmingham University.

HAROLD D. MARTIN has joined the staff of the Bengal Iron and Steel Company, and has gone to India.

WILLIAM MCNEILL has left for Mexico.

C. W. MOORE, the London manager and secretary of the Consolidated Mines Selection Company, has been seriously ill for some months, but we are glad to hear that he is now recovering, having greatly benefited by a stay at Brighton. He hopes to return to business in a week or two.

HORACE G. NICHOLS has gone from Mexico to British Columbia.

D. A. THOMPSON is here from West Africa.

L. A. PARSONS has resigned the position of associate editor of the *Mining and Scientific Press*.

W. PELLEW-HARVEY has returned from British Columbia.

S. F. POLLARD has been appointed manager of the office which Brunner, Mond & Co., Ltd., have established at Melbourne.

J. W. RUSSELL has been appointed professor of geology in the Western University, London, Ontario.

H. HARDY SMITH is here from Korea, and is sailing shortly for Australia.

DR. A. W. STICKNEY has returned from Russia after long detention in Moscow, and is going shortly to France.

E. H. WALKER, an engineer with the Utah Copper Co., has joined the staff of the Union Minière in Congo State.

A. B. WATSON is here from West Africa.

H. H. YUILL is back from Canada and is going to West Africa.

J. P. IDDINGS, the eminent American petrologist, author of "Rock Minerals" and "Igneous Rocks," died in August, at the age of 63. The following appreciation of his work, written by Dr. Willet G. Miller, appears in the *Canadian Mining Journal* for October 1: "Joseph Paxon Iddings was formerly professor of petrology in the University of Chicago and at one time a geologist of the U.S. Geological Survey. He became a member of the staff in Chicago in 1892, at the time of the organization of that geological department which has had such a great influence on the science through its students and the writings and research work of the members of the staff. The work of Chamberlin, Salisbury, Penrose, and Iddings, all original members of the staff, has done, at least, as much, it is safe to say, to advance the science during the last thirty years as that of any other four men throughout the world. During the closing decades of the last century, petrology, or as it was more commonly called, petrography, was probably the most popular branch of geology among post-graduate students. The microscopic study of rocks in thin sections was really founded by an Englishman, Sorby, but like certain other sciences was developed in Germany. Heidelberg and Leipzig attracted practically all students of petrography from North America until G. H. Williams began his distinguished career as teacher and investigator on the staff of Johns Hopkins University, ended by his untimely death in 1894. Iddings' professorial work in Chicago continued until 1908. Through their teaching Williams and Iddings exerted a profound influence on petrography. After they took up professorial work it was no longer necessary to leave North America for the best instruction obtainable in this specialized subject. Iddings' epoch-making work on the rocks of the Yellowstone National Park and his books on 'Rock Minerals' and on 'Igneous Rocks' will serve as lasting memorials to his too brief career. The passing of his contemporaries at early ages, George H. Williams, J. Francis Williams, and, more recently, L. V. Pirsson, deprived petrography of remarkable students and investigators. The 'Quantitative Classification of Igneous Rocks,' the joint production of Cross, Iddings, Pirsson, and Washington, has done much to make petrography a more exact science. The igneous rocks have come to be recognized as the most important factors in the genesis of metalliferous deposits. Much of the research work of men like Iddings might appear to be of an abstract or academic nature, but, as in the case of other sciences, the study of the pure science has had a far-reaching effect on the applied."

TRADE PARAGRAPHS

THE HOFFMANN MANUFACTURING CO., LTD., of Chelmsford, are putting on the market a roller-bearing suitable for mine-cars.

PETER BROTHERHOOD, LTD., makers of steam and gas engines, air-compressors, etc., have moved their London office from Queen Anne's Gate to Central House, Kingsway, London, W.C.2.

THE GENERAL ELECTRIC CO., LTD., head offices, 67, Queen Victoria Street, London, E.C.4, send us their catalogue dealing with industrial and street lighting as carried out by means of their Osram lamps.

SIEMENS BROTHERS & CO., LTD., and SIEMENS BROTHERS DYNAMO WORKS, LTD., are moving their head offices from Kensington to Caxton House, Westminster.

THE STAR DRILLING MACHINE CO., of Akron, Ohio, and 2, Rector Street, New York, send us a new catalogue giving full particulars of their system of drilling for water, oil, and coal, and for other minerals.

THE WORTHINGTON PUMP AND MACHINERY CORPORATION, of 115, Broadway, New York, send us their Bulletin D 1302, dealing with Forged Fluid End Pumps.

NISSENS, LTD,, of 174, Corporation Street, Birmingham, are erecting extensive storage houses for the Government at Hull on the "Nissen Hut" principle, consisting of 18 buildings each 552 ft. and 40 ft. wide.

BRUCE PEEBLES & CO., LTD., of Edinburgh, send us particulars of their exhibits at the Shipbuilding, Engineering, and Electrical Exhibition, held at Glasgow. This firm is the largest maker in Scotland of electric power plant of all kinds.

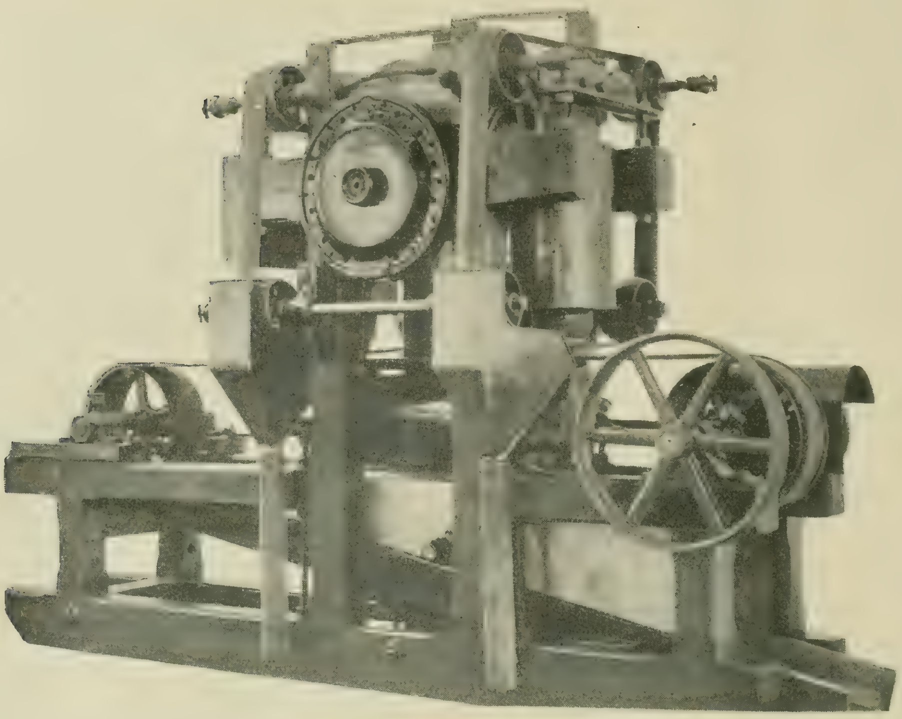
THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO., of East Pittsburgh, Pennsylvania, send us pamphlet No. 3,461 which describes and illustrates their automatic current regulator for electric arc furnaces having movable electrodes.

THE PACIFIC TANK AND PIPE CO., of 302, Market Street, San Francisco, is now represented in this country by J. F. MITCHELL-ROBERTS, of 2, Broad Street Place, London, E.C.2. The company makes a specialty of pipes, tanks, and vats made of Californian redwood.

T. COOKE & SONS, LTD., of the Buckingham Works, York, send us pamphlets relating to their post-war pattern transit theodolites and tacheometers. These pamphlets contain complete descriptions of the instruments, with instructions as to their use and adjustment. The firm also publish a pamphlet dealing with their transits designed on the American pattern.

SIR W. G. ARMSTRONG, WHITWORTH & CO., LTD., of 8, Great George Street, Westminster, send us a series of leaflets describing the Armstrong-Jensen Water Turbines, of the Francis, Spiral Francis, and Impulse types. These turbines have wide applications for the production of hydro-electric power, and are adapted to the requirements of the mining engineer and metallurgist.

JOHN & EDWIN WRIGHT, LTD., of the Universe Rope Works, Birmingham, are showing their specialties at the Shipbuilding, Engineering, and Electrical Exhibition, held this month at Glasgow. For engineering purposes they are showing special non-rotating ropes for cranes, hoists, etc.; for mining purposes wire ropes of special construction for winding, sinking, haulage, cage conductors, aerial cableways, etc.; and for shipping, galvanized steel wire ropes for use as hawsers, tow-lines, trawl-warps, running rigging, etc., as well as for launching. For oil-well drilling the firm's ropes are used for drilling-cables, casing-lines, sand and baling lines. They are also used for logging purposes.



THE DINGS WET MAGNETIC CONCENTRATOR.

THE DINGS MAGNETIC SEPARATOR CO., of Milwaukee, Wisconsin, send us particulars of their separator for wet concentration. This separator, type "B-W," is built upon a combination of the Wetherill and Dings principles. The pulp is fed on to a vanner belt which conveys it under the two magnetic poles. The magnetic material attracted to the poles is removed by two cross belts. There is a north pole and south pole of the Wetherill type, and the coils are horizontal. The non-magnetic material is discharged over the drive pulley into the launder underneath. The standard Wetherill machine has coils both above and below the belt. The lower coil would probably be water-soaked in a short time if used upon a wet machine. A Dings bridge-bar has been substituted for the lower Wetherill coil, completing the magnetic circuit. The intensities obtained are equal to the standard Wetherill machine. The cross belts which remove the magnetic material must be placed above the surface of the pulp, consequently a very large magnetic gap is required. The inversed law of magnetism and the large gap necessitate a high intensity field to attract the magnetic particles of ore in the pulp. There is a distinct agitating action caused by the magnetic flux in the pulp underneath the pole. This zone of agitation is of assistance in thoroughly washing and cleaning the magnetic particles and freeing them from any attached non-magnetic material. In this regard it is necessary to say that upon a dry machine, where the material is fed upon a belt, a cluster of long grains will stand up something like a cone. As they are pulled toward the pole, they sometimes enclose and grip a small piece of non-magnetic material and remove it. This is one of the causes of finding non-magnetic material discharged with the magnetic. The agitation in the water beneath the poles removes this difficulty and the machine is making a very clean product. One of the difficulties in dry magnetic separation has been the clinging of fine material and particles to the belt, and finer than 100 mesh was exceedingly difficult to separate cleanly. The wet machine is making a high-grade zinc concentrate from ore ground to 60% through 200 mesh screen. The consistency of the pulp is about one of solids to four of water. It has the capacity of 100 tons per 24 hours on a 48 in. belt. Owing to the fact that this is a very high intensity machine and that there is agitation, it is not necessary to run the machine one grain deep. Consequently it is possible to get a much larger capacity upon fine material than has heretofore been accomplished upon dry ore. One of the main objections to magnetic separation arises from the formation of dust and dirt on account of handling dry material, as well as the cost of drying. This machine removes this objection, and it can be used in connection with other wet concentration machines. The coils of the machine are thoroughly impregnated by vacuum and pressure, and then encased, thus making them waterproof. The current can be varied by a large rheostat, and the poles may be raised or lowered independently to give any width of gap desired. The power required to drive and energize the coils is small. The machine is sold outright, and not upon a royalty basis. It is made in five sizes, with belt widths from 18 to 60 inches. The performance of these machines at the Trail smelter was described in the MAGAZINE for June last. In the accompanying illustration is shown a laboratory machine with much greater intensity than those of the usual types, and it is intended for experimental work on ores of low magnetic susceptibility.

Hadfields, Ltd., of Sheffield, received the members of the British Commercial Gas Association, who were attending the annual convention of the association held on October 19 and 20, and showed them over their East Hecla Works. The special feature of the visit was an inspection of the new foundry for small steel castings. Most of the buildings in this foundry were erected during the war period for use in shell manufacture. Since the war these shops have been stripped of all shell plant, and with various alterations and additions are now admirably suited for their new purpose. New buildings of various kinds have also been built to complete the scheme. The whole scheme covers an area of 12½ acres, of which 7½ acres are covered by roofs. The main building (about 4 acres), in which is housed the foundry and steel-making plant, is well equipped with modern plant, a feature being the use made of electric tractors for haulage purposes. This plant is capable of an output of 400 to 500 tons per week. The foundry has been laid out to deal with all types of small steel castings for colliery, mining, engineering, and other industries, but larger castings could be made if necessary. Included in the foundry plant are heating fires, core and drying stoves, moulding machines, etc. ; also there is installed a completely equipped compo mill, with sand-storage accommodation, sand-mixing machines, and grinding mills. The heat treatment shop (about 1 acre) is equipped with 16 furnaces of the raised bottom and roller bottom variety ; also tanks for quenching. Housed in this shop is an up-to-date sand-blast. The other shops include : Rumbling shop equipped with three electrically driven rumblers ; grinding and fettling shop (½ acre) fitted up with a large number of grinding wheels, all connected up to a modern dust-extracting plant ; machine shop (nearly ¾ acre) ; inspection, assembling, and forwarding shop (nearly ½ acre) ; wheel and axle shop equipped with pneumatic hammers, smiths' hearths, and dipping pans ; moulding-box shop ; storage shed for coke, etc. ; gantry for raw materials, 80 ft. span, 240 ft. long, fitted with a 10-ton overhead electric travelling crane suitably designed to work with an electric lifting magnet ; one 7-ton stationary electric luffing jib crane, 50 ft. radius of action ; associated with this crane is a breaking-up tub. All shops are well fitted up with overhead electric cranes, railway connections are coupled up to all necessary places, and there is installed a 2 ft. gauge inter-shop communication railway system with all facilities to deal with the various classes of work. It is estimated that when the new departments are fully equipped employment will be found for 500 workmen in the foundry alone, and with the annealing, machining, and other departments, say 1,000 workmen.

COMMERCIAL MOTOR SHOW AT OLYMPIA.

An exhibition of commercial motors was held at Olympia, Kensington, during the ten days ended October 23. Some of the space was occupied by motor buses, charabancs, and taxi-cabs, but the cars intended for the transport of heavy goods appeared to attract the chief attention. For mining engineers this type of haulage vehicle presents many points of interest, especially the vehicles with side or back tip. It is not possible in the space at our disposal to do more than mention the names of a few of the makers of these petrol-driven tipping wagons : The Daimler Co., of Coventry ; Walker Brothers Ltd., of Wigan ; North-Western Motors, Ltd., of Liverpool ; Republic Trucks, Ltd., of London ; Associated Equipment Co., Ltd., of Walthamstow ; Guy Motors, Ltd., of Wolverhampton ; Enfield-Allday Motors, Ltd., of Birmingham ; W. & G. Du Cros, Ltd., of Acton ; British Berna Motor Lorries, Ltd., of Guildford ; Star Engineering Co., Ltd., of Wolverhampton ; Albion Motor Car Co., Ltd., of Glasgow ; Commercial Cars, Ltd., of Luton ; J. I. Thornycroft & Co., Ltd., of Basingstoke ; J. & E. Hall, Ltd., of Dartford ; Société Anonyme Adolphe Saurer, Arbon, Switzerland ; Sentinel Wagon Works, Ltd., of Shrewsbury. G. Scammell & Nephew, Ltd., of West Watford, Hertfordshire, showed their six-wheeled wagon, in which the fore part of the carrier body rests on a turntable over the back wheels of the motor. W. H. Dorman & Co., Ltd., of Stafford (makers of the wave-transmission rock-drill), showed many types of motor-engines. Ferodo, Ltd., of Chapel-en-le-Frith, showed their clutch and brake linings, which find application in winding engines. The Skefko Ball Bearing Co., Ltd., of Luton, and the Hoffmann Manufacturing Co., Ltd., of Chelmsford, showed their respective specialties in bearings. The British Thomson-Houston Co., Ltd., of Coventry, showed a number of electrical accessories. The Coventry Chain Co., Ltd., of Coventry, had an exhibit of their chains, of the roller and inverted-tooth types, used in the transmission of power. Hans Renold, Ltd., of Manchester, also exhibited their roller-chains used for power transmission. The steel producers and the makers of special alloys were well represented. Any of the above-named companies will send particulars on application.

METAL MARKETS

Copper.—After showing a considerable amount of strength during the early part of October, due to persistent heavy buying of standard warrants in connection with Italian sulphate requirements, the market took on a distinctly weaker appearance. The fact of the matter is that there is too much copper above ground at present. Had demands only kept up at a reasonable pace and had Europe not practically ruined itself over the war, there would have been reasonable hope for consumption absorbing the surplus metal. As it is, financial considerations have proved paramount and have forced the big American group to make cut after cut without so far stimulating business to any appreciable extent. From 18½ cents, which was the price ruling in America at the beginning of the month, successive reductions have brought the quotation down to about 15 cents, and it is doubtful if even at this level sufficient buying power will be developed to stem the decline. One of these days intimation will be received that a large block of copper has changed hands in America, and the sequel is bound to be an all-round advance in prices. Whether such an advance could be maintained is a matter which the future only could decide. The coal strike in this country has of course had a depressing influence on the market, and there seems to have been some realizing also of standard copper by Italian interests who may have found that they have bought more than they could carry. It is certainly a fact that Italy's total purchases were on a wholly unexpected scale, and represent several times over the amount of sulphate which that country could reasonably be expected to absorb. The position at the Rio Tinto mines has been exceedingly unsatisfactory, and the Spanish Government were greatly distressed about the state of affairs there. Apparently, however, there seems some chance of the situation being improved, advices from Huelva indicating that a good many men have resumed work. There has been a good deal of talk about the Arizona Copper Co. It is understood that the Phelps-Dodge interests have been negotiating for the purchase of the entire property, and it was reported at one time

Daily London Metal Prices: Official Closing
Copper, Lead, Zinc, and Tin per Long

	Copper				
	Standard Cash	Standard (3 mos.)	Electrolytic	Wire-Bars	Best Selected
Oct.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
11	96 10 0 to 96 15 0	95 10 0 to 95 15 0	109 0 0 to 113 0 0	111 0 0 to 113 0 0	104 0 0 to 105 0 0
12	95 0 0 to 95 5 0	94 0 0 to 94 5 0	109 0 0 to 113 0 0	111 0 0 to 113 0 0	104 0 0 to 105 0 0
13	96 10 0 to 97 0 0	94 5 0 to 94 10 0	108 0 0 to 110 0 0	109 0 0 to 110 0 0	104 0 0 to 105 0 0
14	93 5 0 to 93 10 0	91 5 0 to 91 10 0	106 0 0 to 108 0 0	107 0 0 to 108 0 0	104 0 0 to 105 0 0
15	92 10 0 to 93 0 0	88 5 0 to 88 10 0	104 0 0 to 106 0 0	105 0 0 to 106 0 0	102 0 0 to 103 0 0
18	93 0 0 to 93 10 0	88 5 0 to 88 10 0	102 0 0 to 106 0 0	105 0 0 to 106 0 0	102 0 0 to 103 0 0
19	92 10 0 to 93 0 0	89 10 0 to 89 15 0	102 0 0 to 106 0 0	105 0 0 to 106 0 0	102 0 0 to 103 0 0
20	92 0 0 to 92 10 0	88 10 0 to 89 0 0	101 0 0 to 105 0 0	104 0 0 to 105 0 0	102 0 0 to 103 0 0
21	91 0 0 to 91 10 0	89 5 0 to 89 10 0	101 0 0 to 105 0 0	104 0 0 to 105 0 0	102 0 0 to 103 0 0
22	89 15 0 to 90 0 0	88 15 0 to 89 0 0	100 0 0 to 104 0 0	103 10 0 to 104 0 0	100 0 0 to 102 0 0
25	91 10 0 to 92 0 0	90 10 0 to 90 15 0	100 0 0 to 104 0 0	103 0 0 to 104 0 0	100 0 0 to 102 0 0
26	89 5 0 to 89 10 0	88 5 0 to 88 10 0	99 0 0 to 101 0 0	100 0 0 to 101 0 0	99 0 0 to 100 0 0
27	88 5 0 to 88 10 0	87 15 0 to 88 0 0	98 0 0 to 101 0 0	100 0 0 to 101 0 0	99 0 0 to 100 0 0
28	89 0 0 to 89 10 0	88 10 0 to 88 15 0	97 0 0 to 99 0 0	98 0 0 to 99 0 0	99 0 0 to 100 0 0
29	89 0 0 to 89 10 0	88 10 0 to 88 15 0	97 0 0 to 99 0 0	98 0 0 to 99 0 0	96 0 0 to 98 0 0
Nov.					
1	91 0 0 to 91 5 0	89 15 0 to 90 0 0	96 0 0 to 98 0 0	96 0 0 to 98 0 0	96 0 0 to 98 0 0
2	91 10 0 to 91 15 0	90 5 0 to 90 10 0	96 0 0 to 98 0 0	96 0 0 to 98 0 0	96 0 0 to 98 0 0
3	91 10 0 to 91 15 0	91 0 0 to 91 5 0	97 0 0 to 99 0 0	97 0 0 to 99 0 0	96 0 0 to 98 0 0
4	92 10 0 to 92 15 0	91 12 6 to 91 17 6	100 0 0 to 102 0 0	100 0 0 to 102 0 0	96 0 0 to 98 0 0
5	90 5 0 to 90 10 0	89 10 0 to 89 15 0	100 0 0 to 102 0 0	100 0 0 to 102 0 0	99 0 0 to 100 0 0
8	90 5 0 to 90 10 0	89 0 0 to 89 10 0	100 0 0 to 102 0 0	100 0 0 to 102 0 0	99 0 0 to 100 0 0
9	90 10 0 to 90 15 0	89 5 0 to 89 15 0	100 0 0 to 102 0 0	100 0 0 to 102 0 0	99 0 0 to 100 0 0

that the deal had been definitely put through, but latest advices indicate that there has been another hitch, and that the matter is held up. It is quite possible that the collapse in the American copper market lies at the root of the matter.

Average prices of cash standard copper: October 1920, £93. 10s. 1d.; September 1920, £96. 13s. 4d.; October 1919, £103. 10s. 11d.; September 1919, £100. 17s. 4d

TIN.—During the first half of October prices of tin dropped away steadily, the loss over the first fortnight or so exceeding £30 a ton, but from this level there was a well sustained recovery. The worst part of the fall was experienced following upon the outbreak of the colliers' strike which brought about general realizing and bear selling, while the leading operators who are generally credited with holding the position practically in the hollow of their hand did nothing to stem the decline. Reduced offers from the East, however, and a feeling that the fall had been overdone were instrumental in bringing about a sharp recovery, though it might be unwise to trust the advance too far. Tin is notoriously a dangerous market, and never more so than when it is more or less under the control of one group as is the case to-day. That higher prices, possibly considerably higher, may be seen next year is quite likely, but the tail end of the year is not usually a very propitious season for engineering big rises, and a movement of this kind may be deferred until nearer the period when the usual heavy spring buying by America manifests itself. Throughout the month America has been a decided blot on the situation. Prices there have been far below parity, and holders have been liquidating while consumers have done little or nothing. The time is ripe, however, for United States consumers to display a little more energy. Home demand has of course been retarded by the coal strike.

Average prices of cash standard tin: October 1920, £258. 8s. 8d.: September 1920, £270. 7s. 3d.; October 1919, £279. 4s. 10d.; September 1919, £280. 3s. 11d.

LEAD.—The lead market has been remarkably firm during October. In spite of pretty good arrivals, prompt metal has been in urgent demand, the remarkable thing being that consumers everywhere require immediate deliveries. The long-drawn-out strike in Australia seems theoretically to have come to an end, but information is still awaited that productive operations have been resumed. Even under the most favourable circumstances it will take months before new output can come upon the market here, and meantime there is a possibility, now that the coal strike is out of the way, of a rather sharp scarcity of prompt metal. Burma has been sending along rather more plentiful supplies, and quite a lot of lead is dribbling in from Spain in spite of the fact that producers there are insistent in their statements that production is unremunerative. One big concern is credited with holding a stock of at least 20,000 tons for which £40 a ton is wanted. The likelihood of this price being realized at the present moment seems remote, although the position of the metal is sound enough, while there is always a chance, if the dollar exchange really gets on to its feet again, of America shipping lead to this side. One cause of the firmness in the London market recently was of course heavy buying of lead here for shipment back to the United States, which metal seems to have broken the market pretty badly on the American seaboard, and there is now talk of some of this lead being again sent back across the Atlantic. It is obviously an anomalous thing when a big producing country goes abroad for supplies, and this tends to make people cautious in this particular instance.

Average prices of lead: October 1920, £35. 2s. 1d.; September 1920, £35. 7s. 6d.; October 1919, £28. 15s. 11d.; September 1919, £25. 12s. 6d.

SPELTER.—There has not been very much movement in spelter, the day-to-day fluctuations being limited to a few shillings, and it is rather difficult to say with any degree of confidence what the indications are for the near future. Germany has sold spelter fairly freely, and thanks to the collapse in the mark can realize handsome prices for the material they have to dispose of; but Belgium is in a different position, and smelters there are unanimous in declaring that they cannot go on producing at current prices. It is supposed that there is a pretty big stock also in Norway, where producers make the same complaint as those in Belgium, and have indeed for the time being withdrawn all their quotations. While the fall in sterling exchange with

PRICES ON THE LONDON METAL EXCHANGE.
Tons; Silver per Standard Ounce; Gold per Fine Ounce.

Lead		Zinc (Spelter)	Standard Tin		Silver		Gold	
Soft Foreign	English		Cash	3 mos.	Cash	Forward		
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.			s. d.	Oct.
34 12 6 to 34 10 0	35 15 0	40 10 0 to 40 17 6	263 15 0 to 264 0 0	269 0 0 to 269 10 0	$53\frac{3}{8}$	$53\frac{1}{8}$	117 3	11
34 10 0 to 34 7 6	35 15 0	40 10 0 to 41 15 0	259 0 0 to 259 10 0	263 10 0 to 264 0 0	$54\frac{1}{4}$	54	117 6	12
34 5 0 to 34 0 0	35 10 0	40 0 0 to 41 5 0	256 0 0 to 256 10 0	260 15 0 to 261 0 0	$56\frac{1}{4}$	$55\frac{3}{4}$	117 6	13
34 10 0 to 34 5 0	35 10 0	40 2 6 to 41 2 6	249 0 0 to 249 10 0	254 10 0 to 255 0 0	$55\frac{1}{4}$	$54\frac{1}{4}$	117 6	14
34 17 6 to 34 10 0	36 0 0	39 10 0 to 40 10 0	244 10 0 to 245 10 0	249 10 0 to 250 0 0	$53\frac{5}{8}$	$53\frac{1}{8}$	118 0	15
35 5 0 to 34 15 0	36 5 0	39 7 6 to 40 7 6	238 10 0 to 239 0 0	245 0 0 to 246 0 0	$52\frac{1}{8}$	$52\frac{1}{8}$	118 10	18
35 15 0 to 35 10 0	37 0 0	39 0 0 to 40 0 0	241 15 0 to 242 0 0	247 10 0 to 248 0 0	$50\frac{1}{2}$	$50\frac{1}{2}$	120 3	19
35 15 0 to 35 12 6	37 0 0	38 15 0 to 39 15 0	250 0 0 to 250 10 0	255 10 0 to 256 0 0	$51\frac{3}{8}$	$51\frac{1}{8}$	120 3	20
36 2 6 to 35 17 6	37 5 0	38 15 0 to 39 17 6	251 10 0 to 251 15 0	256 10 0 to 256 15 0	$53\frac{1}{4}$	$53\frac{1}{8}$	119 3	21
36 0 6 to 35 15 0	37 5 0	39 0 0 to 40 0 0	248 10 0 to 249 0 0	254 15 0 to 255 0 0	$52\frac{5}{8}$	$52\frac{5}{8}$	119 6	22
36 2 6 to 35 17 6	37 5 0	39 10 0 to 40 10 0	251 5 0 to 251 15 0	257 5 0 to 257 10 0	$52\frac{1}{2}$	$52\frac{1}{2}$	118 2	25
36 5 0 to 35 17 6	37 10 0	39 15 0 to 40 15 0	258 10 0 to 258 15 0	263 10 0 to 264 0 0	$52\frac{1}{4}$	$52\frac{1}{8}$	118 2	26
36 7 6 to 35 15 0	37 10 0	39 0 0 to 40 0 0	261 15 0 to 262 0 0	265 15 0 to 266 0 0	$52\frac{1}{8}$	52	117 9	27
36 10 0 to 35 15 0	37 10 0	38 15 0 to 39 0 0	265 10 0 to 266 0 0	267 0 0 to 267 10 0	52	$51\frac{7}{8}$	117 11	28
36 5 0 to 35 15 0	37 10 0	39 0 0 to 39 15 0	267 5 0 to 267 15 0	269 10 0 to 270 0 0	$52\frac{3}{8}$	$52\frac{1}{4}$	118 1	29
								Nov.
35 17 6 to 35 10 0	37 5 0	38 0 0 to 39 7 6	266 10 0 to 267 0 0	267 0 0 to 267 10 0	$52\frac{7}{8}$	$52\frac{3}{4}$	119 2	1
35 17 6 to 35 7 6	37 5 0	37 17 6 to 39 5 0	264 15 0 to 265 0 0	266 10 0 to 266 15 0	$52\frac{5}{8}$	$52\frac{5}{8}$	119 2	2
35 15 0 to 35 5 0	37 5 0	37 15 0 to 39 5 0	262 0 0 to 262 5 0	264 15 0 to 265 0 0	$53\frac{3}{4}$	$53\frac{5}{8}$	119 2	3
35 15 0 to 35 2 6	37 5 0	38 0 0 to 39 7 6	259 5 0 to 259 15 0	263 10 0 to 264 0 0	$54\frac{1}{8}$	$54\frac{1}{8}$	119 6	4
35 15 0 to 35 0 0	37 5 0	37 15 0 to 39 5 0	259 0 0 to 259 10 0	262 15 0 to 263 0 0	$53\frac{7}{8}$	$53\frac{5}{8}$	120 0	5
35 15 0 to 34 15 0	37 5 0	37 10 0 to 38 17 6	251 15 0 to 252 0 0	256 10 0 to 257 0 0	$53\frac{7}{8}$	$53\frac{7}{8}$	122 4	8
35 12 6 to 34 12 6	37 0 0	36 17 6 to 38 5 0	245 15 0 to 246 5 0	251 15 0 to 252 5 0	$53\frac{3}{4}$	$53\frac{3}{4}$	112 4	9

America renders business with the United States out of the question, fairly good quantities have been arriving here from there against old contracts, and the American market has been weak with prices falling pretty steadily all the month. Consumers' trade is everywhere of the slightest, although it improved slightly on the settlement of the coal strike.

Average prices of spelter: October 1920, £40. 5s. 6d.; September 1920, £40. 5s. 6d.; October 1919, £43. 17s. 11d.; September 1919, £41. 8s. 4d.

ZINC DUST.—This article remains steady at £85 per ton for high-grade Australian material, for which there is a steady demand.

ANTIMONY.—The market is quiet, but there is no change in the price of English regulus, which continues at £52 per ton, while special brands are quoted at £55. Foreign material on spot has, however, been sold at £42 to £43 per ton.

ARSENIC.—There is little business moving, the present quotation being about £77. 10s. per ton delivered London or Liverpool.

BISMUTH.—A moderate business has been moving, and the quotation remains at 12s. 6d. per lb.

CADMIUM.—There is not much movement in this market, and the quotation rules at about 6s. 3d. per lb.

ALUMINIUM.—There is no change to report, the price continuing at £165 per ton for the home trade, and £185 for export.

NICKEL.—The quotation is steady at £230 for home and export.

COBALT METAL.—This market has been quiet, but the quotation is steady at 30s. per lb

COBALT OXIDE.—Black oxide stands at about 20s. per lb.

PLATINUM.—The price is lower, and is now nominally quoted at £26 per oz.

PALLADIUM.—The price of this is also down, and is nominally £25 per oz.

QUICKSILVER.—The market has been brought to a lower basis by means of a sharp cut in the price by the chief producers, values coming down to about £15 to £15. 10s. per bottle. Subsequently the tone became rather firmer, however, the lower level having apparently brought out business. The present quotation is about £15. 10s. to £16 per bottle.

SELENIUM.—The quotation remains at about 10s. 6d. to 13s. per lb.

TELLURIUM.—The price of this remains at about 90s. to 95s. per lb.

SULPHATE OF COPPER.—This market has been easy, and the present quotation is about £41 to £42 per ton.

MANGANESE ORE.—Prices are fairly steady, the present quotation being about 3s. 6d. to 3s. 9d. per unit c.i.f. United Kingdom.

TUNGSTEN ORES.—Wolfram 65% is steady at about 24s. 6d. to 25s. c.i.f. per unit.

SILVER.—The market opened the month at 59d. which was the quotation on October 1 for spot standard bars. Values then declined to $53\frac{3}{8}$d. on the 11th and subsequently fluctuated considerably. At the end of the month the quotation was $52\frac{1}{2}$d. per oz.

GRAPHITE.—There is no change in the market, soft velvety flake 85 to 90% being quoted at £60 to £80 per ton. Madagascar, 82 to 85%, is quoted at £25 per ton.

MOLYBDENITE.—The quotation is about 75s. to 80s. per unit c.i.f. U.K., but is quite nominal.

CHROME ORES.—48 to 52% stands at about £8. 10s. per ton c.i.f.

IRON AND STEEL.—During the past month gloom has been cast upon the iron and steel market owing to the decision of the coal miners to strike. In consequence business in both pig iron and the finished trades has been completely held up, while production was seriously interfered with when the strike matured. The full effects of the strike have been felt in this industry, and it will take a considerable time for the markets to recover themselves. It is extremely unfortunate that the stoppage should have come when it did, as Continental competition is now becoming a factor which needs careful consideration. Already Belgian and Luxemburg pig iron is finding its way into consumption here, and as long as the rate of exchange encourages such business such material will continue to arrive. Already both Belgian and German steel is being offered at several pounds below makers' quotations here. When work is resumed there will doubtless have to be a complete revision of prices by makers here to meet the situation. Meanwhile all quotations are nominal.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Par Value
	Oz.	Oz.	Oz.	£
September, 1919	680,359	18,199	698,558	2,967,287
October	705,313	18,409	723,722	3,074,174
November	657,845	20,125	677,920	2,879,834
December	631,833	18,358	650,191	2,761,836
Year 1919	8,111,271	218,820	8,330,091	35,383,974
January 1920	653,295	17,208	670,503	*
February	607,918	17,412	625,330	*
March	689,645	17,391	707,036	*
April	667,926	19,053	686,979	*
May	681,551	17,490	699,041	*
June	699,199	16,758	715,957	*
July	718,521	17,578	736,099	*
August	683,604	18,479	702,083	*
September	665,486	16,687	682,173	*

* Not given in the official returns.

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
September 30, 1919	169,120	12,392	5,294	186,806
October 31	167,499	12,691	4,492	184,682
November 30	164,671	12,565	4,337	181,573
December 31	166,155	12,750	4,271	183,176
January 31, 1920	176,390	12,766	4,796	193,952
February 29	185,185	12,708	5,217	203,110
March 31	188,564	12,788	5,232	206,584
April 30	189,446	12,951	5,057	207,454
May 31	184,722	12,897	4,793	202,412
June 30	179,827	13,036	4,596	197,459
July 31	174,187	13,005	4,521	191,713
August 31	169,263	13,535	4,244	187,042
September 30	163,132	13,716	4,323	181,171

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 65% of the working profit. Figures for yield and profit for 1919 based on par value of gold; subsequently gold premium included.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
July, 1919	2,134,668	27 10	21 9	6 0	611,118
August	2,036,128	28 5	22 11	5 5	551,203
September	2,019,109	28 6	22 10	5 7	560,979
October	2,108,698	28 3	22 6	5 10	612,841
November	1,933,526	28 8	23 5	5 5	521,472
December	1,845,088	28 8	25 6	3 10	354,098
Year 1919	24,043,638	28 7	22 11	5 6	6,605,509
January, 1920	2,038,092	34 4	24 2	10 2	1,036,859
February	1,869,180	35 1	28 3*	6 10*	644,571*
March	2,188,104	31 8	25 2	6 6	716,610
April	2,065,446	31 5	26 3	5 2	533,940
May	2,117,725	31 9	25 11	5 10	618,147
June	2,146,890	31 10	25 2	6 8	692,510
July	2,194,050	33 6	24 6	9 0	985,058
August	2,057,560	36 11	25 0	11 11	1,226,906

* Results affected by the back-pay disbursed in accordance with new wages agreement.

Production of Gold in Rhodesia and West Africa.

	Rhodesia		West Africa	
	1919	1920	1919	1920
	£	oz.	£	
January	211,917	43,428	104,063	
February	220,885	44,237	112,616	
March	225,808	45,779	112,543	
April	213,160	47,000	109,570	
May	218,057	46,266	100,827	No official returns published.
June	214,215	45,054	106,612	
July	214,919	46,208	102,467	
August	207,339	48,740	103,112	
September	223,719	45,471	100,401	
October	204,184	—	91,352	
November	186,462	—	98,322	
December	158,835	—	98,806	
Total	2,499,498	412,183	1,240,691	

Transvaal Gold Outputs.

	August		September	
	Treated	Yield	Treated	Yield
	Tons	Oz.	Tons	Oz.
Aurora West	10,400	£15,623	9,850	£14,879*
Brakpan	52,250	21,477	56,850	23,724
City Deep	90,500	36,805	84,000	33,837
Cons. Langlaagte	44,000	£69,022	39,500	£68,442*
Cons. Main Reef	51,000	17,359	49,000	17,190
Crown Mines	185,000	56,962	179,000	56,640
Durban Roodepoort Deep	23,800	7,626	21,800	7,351
East Rand P.M.	129,000	37,530	119,000	33,687
Ferreira Deep	33,800	11,438	32,000	11,802
Geduld	45,000	15,797	44,100	15,347
Geldenhuis Deep	48,500	13,584	48,400	13,064
Glynn's Lydenburg	3,800	£8,947	3,616	£7,838*
Goch	13,600	£17,104	13,500	£17,499*
Government G.M. Areas	128,000	£278,456	133,500	£295,180*
Kleinfontein	46,460	12,957	47,800	12,660
Knight Central	26,500	7,610	27,000	7,158
Knights Deep	89,400	16,437	46,850	7,510
Langlaagte Estate	42,500	£71,966	38,700	£67,089*
Luipaard's Vlei	19,000	£27,043	16,060	£23,330*
Meyer & Charlton	14,300	£50,790	13,300	£48,895*
Modderfontein	85,000	44,309	86,000	43,671
Modderfontein B	55,000	28,653	53,000	28,983
Modderfontein Deep	42,300	21,858	42,700	21,920
Modderfontein East	20,700	7,323	24,200	9,857
New Unified	11,100	£15,853	11,200	£14,960*
Nourse	44,100	13,630	42,000	13,118
Primrose	20,500	£22,851	20,000	£22,839*
Princess Estate	—	1,133	—	884
Randfontein Central	125,000	£186,337	116,000	£179,488*
Robinson	41,100	8,625	41,300	8,702
Robinson Deep	55,700	16,770	50,300	15,921
Roodepoort United	24,000	£28,097	24,600	£26,918
Rose Deep	58,000	14,948	52,000	13,219
Simmer & Jack	56,600	12,712	54,500	12,998
Springs	41,000	19,017	40,000	17,364
Sub Nigel	11,000	6,502	9,500	6,342
Transvaal G.M. Estates	17,550	£33,914	16,770	£31,703*
Van Ryn	32,750	£47,603	31,500	£47,293*
Van Ryn Deep	47,850	£150,175	47,000	£145,289*
Village Deep	53,300	16,109	48,500	15,192
Village Main Reef	15,000	4,049	15,500	4,070
West Rand Consolidated	34,000	£52,905	31,600	£50,629*
Witwatersrand (Knights)	35,350	£57,084	33,500	£59,826*
Witwatersrand Deep	34,400	9,118	32,000	8,719
Wolhuter	32,200	9,112	32,800	8,908

* Output valued at 115s. per oz.

West African Gold Outputs.

	August		September	
	Treated	Value	Treated	Value
	Tons	Oz.	Tons	Oz.
Abbontiakoon	7,361	£13,010	6,558	£11,229
Abosso	4,581	1,741	5,500	2,179
Akoko	—	—	156	131
Ashanti Goldfields	3,728	4,530	5,906	7,237
Obbuassi	—	—	790	£1,806*
Prestea Block A	10,028	£16,018	9,439	£15,168
Taquah	3 250	1,852	3,185	1,876

* At par.

Rhodesian Gold Outputs.

	August		September	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Falcon	15,608	34,212*	15,072	29,774*
Gaika	3,682	5,678	3,849	5,516
Globe & Phœnix	6,547	7,985†	6,063	6,374†
London & Rhodesian	2,670	2,627	2,195	2,177
Lonely Reef	5,270	5,213†	5,300	5,257†
Planet-Arcturus	4,580	7,283	4,800	2,141†
Rezende	5,500	2,482†	5,600	2,481†
Rhodesia, Ltd.	503	167	294	111
Rhodesia G.M. & I.	575	293†	603	329†
Shamva	52,400	47,372	49,850	46,029‖
Transvaal & Rhodesian	1,550	5,695	1,500	5,563

* Gold, Silver and Copper; † Ounces Gold; ‖ Gold at 110s. per oz.

West Australian Gold Statistics.—Par Values.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
October, 1919	586	64,987	65,573	278,535
November	1,171	64,823	65,994	280,323
December	831	27,334	28,165	162,575
January, 1920	836	25,670	26,506	112,590
February	1,928	49,453	51,381	218,251
March	—	54,020	54,020	229,461
April	835	56,256	57,091	242,506
May	227	50,976	51,203	217,495
June	502	56,679	57,181	242,638
July	—	48,341	48,341	205,340
August	167	54,258	54,425	231,185
September	141	54,940	55,081	233,963
October	174	53,801	53,975	229,275

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1919	1920	1919	1920	1919	1920
	£	Oz.	£	Oz.	£	£
January	36,238	7,105	37,100	4,724	18,000	28,000
February	46,955	8,677	43,330	7,200	24,000	15,000
March	40,267	24,126	48,000	6,973	16,000	22,000
April	63,818	6,368	61,200	8,368	24,000	12,000
May	37,456	13,263	38,200	8,432	16,000	13,800
June	41,465	15,707	44,600	13,725	17,000	8,700
July	37,395	12,782	42,060	9,596	22,000	17,410
August	51,564	12,809	49,700	9,973	20,000	17,168
September	76,340	—	37,120	11,800	13,000	13,872
October	39,018	—	36,100	—	28,000	24,752
November	40,735	—	32,720	—	51,000	—
December	63,311	—	44,500	—	31,000	—
Total	575,260	99,736	514,630	80,791	280,000	172,702

Australasian Gold Outputs.

	August		September	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Associated	5,590	7,311	5,896	7,364
Blackwater	1,493	3,574	1,657	3,384
Bullfinch	6,150	1,092‡	5,800	1,711†
Cock's Pioneer	—	—	15,000*	1,294‖
Golden Horseshoe	11,472	4,892‡	11,040	4,812†
Great Boulder Prop.	9,305	27,884	8,543	25,594
Ivanhoe	13,915	5,494‡	13,155	5,948‡
Kalgurli	3,313	4,959	3,204	4,763
Lake View & Star	9,237	10,795	9,355	10,945†
Menzies Consolidated	1,540	2,936	1,510	2,617
Mount Boppy	6,501	4,600	6,286	9,880
Oroya Links	1,557	12,437†	1,376	9,549†
Progress	550	576	192	463
Sons of Gwalia	10,468	15,092	11,529	14,709
South Kalgurli	7,498	2,519‡	7,293	2,127‡
Waihi	13,686	4,309‡	12,805	3,710‡ 29,172§
Waihi Grand Junction	6,100	1,998‡	5,500	1,810‡ 7,905§
Yuanmi	2,005	4,358	1,802	4,402

† Including royalties; ‡ Oz. gold.; * Cu. yd.; ‖ Also 16 tons tin conc.; § oz. silver.

Miscellaneous Gold and Silver Outputs.

	August		September	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
El Oro (Mexico)	34,000	233,000†	32,000	212,000†
Esperanza (Mexico)	18,957	35,260§†	20,983	10,983†‡
Frontino & Bolivia (C'lbia)	2,380	7,853	2,600	6,756
Mexico El Oro (Mexico)	11,800	198,770†	9,355	183,240†
Mining Corp. of Canada	—	93,491*	—	—
Oriental Cons. (Korea)	21,362	76,111†	—	76,500†
Ouro Preto (Brazil)	6,400	2,186‖	5,800	2,150‖
Pato (Colombia)	—	—	96,636**	21,720†
Plymouth Cons. (Calif'rnia)	6,850	7,822	6,000	7,789
St. John del Rey (Brazil)	—	34,000	—	36,000
Santa Gertrudis (Mexico)	28,630	19,740‡	44,640	31,598‡
Sonora (Mexico)	—	—	1,160	3,878*
Tomboy (Colorado)	—	—	17,000	93,000†

§ Loss. † U.S. Dollars. ‡ Profit, gold and silver. ‖ Oz. gold. * Oz. silver. ** Cu yd.

Production of Gold in India.

	1916	1917	1918	1919	1920
	oz.	oz.	oz.	oz.	oz.
January	45,214	44,718	41,420	38,184	39,073
February	43,121	42,566	40,787	36,834	38,872
March	43,702	44,617	41,719	38,317	38,760
April	44,797	43,726	41,504	38,248	37,307
May	45,055	42,901	40,889	38,608	38,191
June	44,842	42,924	41,264	38,359	37,864
July	45,146	42,273	40,229	38,549	37,129
August	45,361	42,591	40,496	37,850	37,375
September	45,255	43,207	40,088	36,813	35,497
October	45,061	43,041	39,472	37,138	35,023
November	45,247	42,915	36,984	39,628	—
December	48,276	44,883	40,149	42,643	—
Total	541,077	520,362	485,236	461,171	375,091

Indian Gold Outputs.

	September.		October.	
	Tons Treated	Fine Ounces	Tons Treated	Fine Ounces
Balaghat	3,200	2,468	3,300	2,367
Champion Reef	11,623	5,016	11,880	5,209
Mysore	18,485	12,851	18,601	12,504
North Anantapur	800	952	800	941
Nundydroog	8,450	5,753	8,788	5,528
Ooregum	12,700	8,457	12,900	8,474

Base Metal Outputs.

		Aug.	Sept.
Arizona Copper	Short tons copper	1,500	1,500
British Broken Hill	Tons lead conc.	—	—
	Tons zinc conc.	—	—
	Tons carbonate ore	—	—
Broken Hill Block 10	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Burma Corp.	Tons refined lead	1,975	2,250
	Oz. refined silver	243,340	251,550
Fremantle Trading	Long tons lead	401	360
Hampden Cloncurry	Tons copper	573	543
	Oz. gold	344	349
Mount Lyell	Tons copper	379	401
	Oz. silver	12,794	12,698
	Oz. gold	375	386
Mount Morgan	Tons copper	547	532
	Oz. gold	9,019	7,695
North Broken Hill	Tons lead	—	—
	Oz. silver	—	—
Pilbarra Copper	Tons ore	—	102
Poderosa	Tons copper ore	430	500
Rhodesian Broken Hill	Tons lead	1,446	1,168
Tanganyika	Long tons copper	—*	—
Tolima	Tons silver-lead conc.	60	60
Zinc Corp.	Tons zinc conc.	—	—
	Tons lead conc.	—	—

* Production suspended by strike.

Imports of Ores, Metals, etc., into United Kingdom.

		September.	October.
Iron Ore	Tons	487,211	426,179
Manganese Ore	Tons	50,934	46,723
Copper and Iron Pyrites	Tons	61,966	51,316
Copper Ore, Matte, and Precipitate	Tons	1,360	2,850
Copper Metal	Tons	12,135	2,205
Tin Concentrate	Tons	2,454	2,784
Tin Metal	Tons	1,888	2,044
Lead, Pig and Sheet	Tons	16,872	16,128
Zinc (Spelter)	Tons	10,688	4,775
Quicksilver	Lb.	55,120	69,651
Zinc Oxide	Tons	298	375
White Lead	Cwt.	23,543	16,926
Barytes	Cwt.	56,469	51,775
Phosphate	Tons	36,210	39,440
Sulphur	Tons	2,190	238
Borax	Cwt.	790	1,067
Other Boron Compounds	Tons	1,187	2,072
Nitrate of Soda	Cwt.	249,911	413,362
Nitrate of Potash	Cwt.	4,129	26,344
Petroleum:			
Crude	Gallons	—	—
Lamp Oils	Gallons	16,737,647	16,733,024
Motor Spirit	Gallons	21,403,584	18,340,130
Lubricating Oils	Gallons	11,559,291	6,971,681
Gas Oil	Gallons	3,012,797	3,960,017
Fuel Oil	Gallons	31,247,535	23,939,554
Total Petroleum	Gallons	83,961,228	69,953,994

Outputs of Tin Mining Companies.
In Tons of Concentrate.

	July Tons	August Tons	Sept. Tons
Nigeria:			
Associated Nigerian	20	–	20
Benue	–	–	–
Bisichi	15	9	11
Bongwelli	1	1	1¾
Dua	3	2½	3
Ex-Lands	35	32	35
Filani	6	–	8
Forum River	8	11	11
Gold Coast Consolidated	4½	4	5
Gurum River	14	14	15
Jantar	6	14	15
Jos	13¼	18	20½
Kaduna	9¼	9½	14¼
Kaduna Prospectors	7	3¾	6¾
Kano	3¾	3	4½
Kuru	14	12	–
Kwall	–	–	–
Lower Bisichi	8¾	8½	9¼
Lucky Chance	1¾	1½	1
Minna	3¼	3	2½
Mongu	30	30	31
Naraguta	46	45	45
Naraguta Extended	25	26	24
Nigerian Consolidated	17	23	33⅛
Ninghi	4	4½	4½
N.N. Bauchi	37½	47¼	53
Offin River	9	10	–
Rayfield	35	35	35
Ropp	78	57	92
Rukuba	4¾	–	3½
South Bukeru	7	6	8½
Sybu	2¼	2⅞	1⅛
Tin Fields	11½	11½	8½
Yarde Kerri	4	2½	4
Federated Malay States:			
Chenderiang	–	–	79*
Gopeng	60	60	60
Idris Hydraulic	19⅓	26¾	17¾
Ipoh	11	15	12
Kamunting	–	–	106*
Kinta	30	30	26
Lahat	44⅔	44⅔	53½
Malayan Tin	60	65½	68½
Pahang	217½	216½	183
Rambutan	15	15	13
Sungei Besi	31	30	30
Tekka	30	30	36
Tekka-Taiping	36	33	39
Tronoh	27	28	37
Cornwall:			
East Pool	95½	86	68⅔
Geevor	38½	25¾	–
Grenville	21	–	–
South Crofty	51¾†	54†	54†
Other Countries:			
Aramayo Francke (Bolivia)	133	153	180
Berenguela (Bolivia)	33	26	30
Briseis (Tasmania)	20	26	21
Deebook (Siam)	–	8½	18
Leeuwpoort (Transvaal)	—	—	265*
Macready (Swaziland)	—	—	21*
Mawchi (Burma)	84†	–	70†
Porco (Bolivia)	10	18	5
Renong (Siam)	43½	45½	59½
Rooiberg Minerals (Transvaal)	45	45	50
Siamese Tin (Siam)	73½	85¼	53½
Tongkah Harbour (Siam)	75	76	85
Zaaiplaats (Transvaal)	28	30	30

* Three months. † Tin and wolfram.

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1915	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons	Tons
January	417	531	667	678	613	547
February	358	528	646	668	623	477
March	418	547	655	707	606	505
April	444	486	555	584	546	467
May	357	536	509	525	483	383
June	373	510	473	492	484	435
July	455	506	479	545	481	484
August	438	498	551	571	616	447
September	442	535	538	520	561	528
October	511	584	578	491	625	—
November	467	679	621	472	536	—
December	533	654	655	518	511	—
Total	5,213	6,594	6,927	6,771	6,685	4,273

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons.

	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons
January	4,316	3,558	3,149	3,765	4,265
February	3,372	2,755	3,191	2,673	3,014
March	3,696	3,286	2,608	2,819	2,770
April	3,177	3,251	3,308	2,855	2,606
May	3,729	3,413	3,332	3,404	2,741
June	3,435	3,489	2,950	2,873	2,940
July	3,517	3,253	3,373	3,756	2,824
August	3,732	3,413	3,259	2,955	2,786
September	3,636	3,154	3,166	3,161	2,734
October	3,681	3,436	2,870	3,221	—
November	3,635	3,300	3,131	2,972	—
December	3,945	3,525	3,023	2,413	—
	43,871	39,833	37,370	36,867	26,680

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
August 25, 1919	130½	£18,297	£140 4 3
September 8	115½	£16,588	£143 12 6
September 22	135½	£19,557	£144 6 9
October 8	72	£10,867	£150 18 7
October 20	32	£5,093	£159 3 2
November 3	34½	£5,235	£151 15 0
November 17	39	£6,161	£157 19 9
December 1	38	£5,905	£155 8 3
December 15	29	£5,133	£176 10 0
December 31	14¾	£2,884	£195 10 10
Total and Average, 1919	2,858	£366,569	£128 5 0
January 12, 1920	31	£6,243	£201 8 0
January 26	51¾	£10,574	£204 6 10
February 9	37½	£7,880	£210 2 8
February 23	53¾	£12,120	£225 10 0
March 8	18	£4,038	£224 7 7
March 22	44	£8,286	£188 6 8
April 6	44½	£8.367	£188 0 5
April 19	33½	£6,375	£190 6 0
May 3	61½	£11,641	£189 5 9
May 17	44	£6,151	£139 16 0
May 31	10	£1,578	£157 16 0
June 14	24¾	£3,278	£132 9 3
June 28	14½	£1,932	£133 4 10
July 12	43¾	£6,133	£140 4 0
July 26	10½	£1,643	£156 10 0
August 9	10½	£1,664	£158 10 0
August 23	27¼	£4,022	£147 12 0
September 6	19	£2,563	£134 18 6
September 20	10	£1,552	£155 5 0
October 4	9	£1,359	£151 0 7
October 18	39½	£5,225	£132 5 11
November 1	9	£1,329	£147 14 5

On October 18 the sales were: East Pool & Agar, (1) 15 tons at £131 per ton, and (1a) 15 tons at £131. 15s. per ton; Tincroft, (1) 4½ tons at £136. 5s. per ton, and (1a) 5 tons at £134. 5s. per ton.

On November 1, Tincroft sold 9 tons at £147. 14s. 5d per ton.

Stocks of Tin

Reported by A. Strauss & Co. Long Tons.

	Aug. 31	Sept 30	Oct. 31
Straits and Australian Spot	1,029	1,082	1,043
Ditto, Landing and in Transit	819	562	556
Other Standard, Spot and Landing	3,551	2,641	3,261
Straits, Afloat	1,168	1,494	2,154
Australian, Afloat	172	132	179
Banca, in Holland	1,494	1,770	2,143
Ditto, Afloat	1,073	1,066	1,222
Billiton, Spot	—	—	—
Billiton, Afloat	—	73	230
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	150	235	100
Total Afloat for United States	7,444	5,540	5,363
Stock in America	3,256	3,731	3,191
Total	20,152	18,326	19,442

Shipments, Imports, Supply, and Consumption of Tin.

Reported by A. Strauss & Co. Long tons.

	Aug.	Sept.	Oct.
Shipments from :			
Straits to U.K.	1,218	1,369	1,470
Straits to America	2,480	2,900	1,770
Straits to Continent	100	260	100
Straits to Other Places	—	—	165
Australia to U.K.	150	235	350
U.K. to America	365	775	225
Imports of Bolivian Tin into Europe	745	1,153	1,117
Supply :			
Straits	3,798	4,529	3,340
Australian	150	235	350
Billiton	—	143	542
Banca	189	429	1,148
Standard	2,902	1,092	1,305
Total	7,039	6,428	6,685
Consumption :			
U K. Deliveries	1,553	2,214	1,670
Dutch ,,	61	223	126
American ,,	3,745	5,635	3,465
Straits, Banca & Billiton, Continental Ports, etc.	10	182	308
Total	5,369	8,254	5,569

Dividends Declared by Mining Companies.

Date	Company	Par Value of Shares	Amount of Dividend
Nov. 2	Abbontiakoon	10s.	5% less tax
Nov. 3	Borax Consolidated	Def. Ord. £1.	1s. less tax
Oct. 16	Broken Hill Proprietary	£1.	9d.
Oct. 27	Deebook Tin Dredging	£1.	1s.
Oct. 28	El Oro	£1.	1s. tax paid
Oct. 15	Kinta Tin	£1.	5% tax paid
Nov. 2	Lake View & Star	4s.	5%
Nov. 2	Mongu Tin	10s.	12½% less tax
Oct. 15	Oroya Links	5s.	3d. tax paid
Oct. 19	Premier Diamond	Def. 2s. 6d	12s. 6d.
Oct. 23	Premier Diamond	Pref. 2s. 6d.	6s. 3d.
Oct. 14	Rio Tinto	Pref. £5.	2s. 6d. less tax
Oct. 18	Scottish Australian Mining	£1.	2½% less tax
Nov. 2	Siamese Tin	£1.	10% less tax
Nov. 3	Tekka-Taiping	£1.	3d. less tax
Oct. 12	Utah-Apex	$5.	25 cents
Oct. 16	Waihi Gold	£1.	1s. tax paid
Nov. 4	Wankie Colliery	10s.	5% less tax
Oct. 23	Wolhuter	£1.	6¼%

PRICES OF CHEMICALS. November 5.

These quotations are not absolute; they vary according to quantities required and contracts running.

		£	s.	d.
Alum	per ton	20	0	0
Alumina, Sulphate of	,,	17	0	0
Ammonia, Anhydrous	per lb.		2	6
,, 0·880 solution	per ton	46	0	0
,, Carbonate	per lb.			7½
,, Chloride of, grey	per ton	60	0	0
,, ,, ,, pure	per cwt.	5	10	0
,, Nitrate of	per ton	60	0	0
,, Phosphate of	,,	120	0	0
,, Sulphate of	,,	24	10	0
Antimony Sulphide, Golden	per lb.		1	6
Arsenic, White	per ton	78	0	0
Barium Sulphate	,,	12	0	0
Bisulphate of Carbon	,,	60	0	0
Bleaching Powder, 35% Cl.	,,	26	0	0
Borax	,,	41	0	0
Copper, Sulphate of	,,	40	0	0
Cyanide of Sodium, 100%	per lb.		1	0
Hydrofluoric Acid	,,			7½
Iodine	,,		16	0
Iron, Sulphate of	per ton	4	0	0
Lead, Acetate of, white	,,	74	0	0
,, Nitrate of	,,	60	0	0
,, Oxide of, Litharge	,,	58	0	0
,, White	,,	63	0	0
Lime, Acetate, brown	,,	20	0	0
,, ,, grey 80%	,,	29	0	0
Magnesite, Calcined	,,	22	0	0
Magnesium, Chloride	,,	15	0	0
,, Sulphate	,,	13	0	0
Methylated Spirit 64° Industrial	per gal.		8	2
Phosphoric Acid	per lb.		1	9
Potassium Bichromate	per lb.		1	9
,, Carbonate 85%	per ton	95	0	0
,, Chlorate	per lb.		0	9½
,, Chloride 80%	per ton	40	0	0
,, Hydrate (Caustic) 90%	,,	105	0	0
,, Nitrate	,,	63	0	0
,, Permanganate	per lb.		3	6
,, Prussiate, Yellow	,,		1	10
,, Sulphate, 90%	per ton	45	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	52	0	0
,, Arsenate 45%	,,	60	0	0
,, Bicarbonate	,,	9	0	0
,, Bichromate	per lb.		1	3
,, Carbonate (Soda Ash)	per ton	16	0	0
,, ,, (Crystals)	,,	7	0	0
,, Chlorate	per lb.			5½
,, Hydrate, 76%	per ton	32	0	0
,, Hyposulphite	,,	31	0	0
,, Nitrate, 95%	,,	24	0	0
,, Phosphate	,,	41	0	0
,, Prussiate	per lb.		1	2
,, Silicate	per ton	11	0	0
,, Sulphate (Salt-cake)	,,	8	0	0
,, ,, (Glauber's Salts)	,,	9	0	0
,, Sulphide	,,	40	0	0
Sulphur, Roll	,,	17	5	0
,, Flowers	,,	17	5	0
Sulphuric Acid, Fuming, 65°	,,	24	0	0
,, ,, free from Arsenic, 144°	,,	6	5	0
Superphosphate of Lime, 18%	,,	5	0	0
Tartaric Acid	per lb.		2	9
Tin Crystals	,,		1	11
Zinc Chloride	per ton	30	0	0
Zinc Sulphate	,,	22	10	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Nov. 6 1919 £ s. d.	Nov. 5 1920 £ s. d.
RAND:		
Brakpan	3 15 0	3 0 0
Central Mining (£8)	10 15 0	8 2 6
City & Suburban (£4)	10 0	7 0
City Deep	3 2 6	2 15 0
Consolidated Gold Fields	2 2 6	1 5 0
Consolidated Langlaagte	1 5 0	16 3
Consolidated Main Reef	12 0	14 6
Consolidated Mines Selection (10s.)	1 12 6	1 1 6
Crown Mines (10s.)	3 7 6	2 12 6
Daggafontein	1 3 9	12 6
Durban Roodepoort Deep	10 0	5 0
East Rand Proprietary	7 9	9 6
Ferreira Deep	13 9	12 0
Geduld	3 0 0	2 7 6
Geldenhuis Deep	12 6	8 0
Gov't Gold Mining Areas	5 0 0	4 5 0
Heriot	11 6	9 0
Johannesburg Consolidated	1 12 6	1 6 6
Jupiter	4 9	1 6
Kleinfontein	13 6	6 6
Knight Central	6 3	4 6
Knights Deep	10 0	6 9
Langlaagte Estate	19 6	15 0
Meyer & Charlton	4 10 0	4 12 6
Modderfontein (10s.)	30 5 0	3 15 0*
Modderfontein B (5s.)	9 0 0	1 15 0‡
Modder Deep (5s.)	2 6 3	2 5 0
Modder East	1 15 0	1 3 9
New State Areas	—	1 11 3
Nourse	15 0	10 0
Rand Mines (5s.)	3 12 6	2 18 9
Rand Selection Corporation	4 15 0	3 7 6
Randfontein Central	19 6	14 0
Robinson (£5)	13 0	7 0
Robinson Deep A (1s.)	1 2 6	12 6
Rose Deep	18 9	17 0
Simmer & Jack	7 0	3 9
Simmer Deep	2 9	3
Springs	2 17 6	2 2 6
Sub-Nigel	1 1 3	15 0
Union Corporation (12s. 6d.)	1 3 6	19 0
Van Ryn	1 0 0	15 0
Van Ryn Deep	4 10 0	3 15 0
Village Deep	16 0	9 3
Village Main Reef	9 0	5 0
West Springs	1 6 3	17 6
Witwatersrand (Knight's)	1 3 9	15 0
Witwatersrand Deep	9 9	8 0
Wolhuter	4 9	5 0
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	16 3	13 9
Transvaal Gold Mining Estates	16 3	10 0
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	29 0 0	16 10 0
Jagersfontein	7 15 0	3 15 0
Premier Deferred (2s. 6d.)	12 0 0	9 0 0
RHODESIA:		
Cam & Motor	9 0	10 0
Chartered British South Africa	1 3 3	15 0
Falcon	13 3	13 0
Gaika	16 3	13 0
Globe & Phœnix (5s.)	16 0	17 0
Lonely Reef	3 5 0	2 17 6
Rezende	4 17 6	2 15 0
Shamva	1 18 9	1 12 6
Willoughby's (10s.)	6 3	5 6
WEST AFRICA:		
Abbontiakoon (10s.)	4 6	3 6
Abosso	14 6	10 0
Ashanti (4s.)	1 4 0	16 6
Prestea Block A	5 9	2 3
Taquah	16 6	13 9
WEST AUSTRALIA:		
Associated Gold Mines	3 3	3 0
Associated Northern Blocks	3 6	3 0
Bullfinch	2 6	3 3
Golden Horse-Shoe (£5)	1 7 6	15 0
Great Boulder Proprietary (2s.)	10 0	6 9
Great Fingall (10s).	1 9	1 6
Hampton Properties	1 10 0	7 6
Ivanhoe (£5)	2 1 3	1 2 6
Kalgurli	11 6	13 9
Lake View Investment (10s.)	1 4 3	14 3
Sons of Gwalia	7 0	6 0
South Kalgurli (10s.)	5 6	5 6

GOLD, SILVER, *cont.*	Nov. 6 1919 £ s. d.	Nov. 5 1920 £ s. d.
OTHERS IN AUSTRALASIA:		
Blackwater, New Zealand	8 9	8 9
Consolidated G.F. of New Zealand	3 9	3 9
Mount Boppy, N.S.W. (10s.)	9	6 0
Progress, New Zealand	2 0	1 9
Talisman, New Zealand	8 9	6 6
Waihi, New Zealand	2 12 6	1 10 0
Waihi Grand Junction, New Z'lnd	14 0	8 9
AMERICA:		
Buena Tierra, Mexico	15 0	11 3
Camp Bird, Colorado	1 3 0	12 9
El Oro, Mexico	18 6	15 6
Esperanza, Mexico	16 9	1 10 0
Frontino & Bolivia, Colombia	10 0	10 0
Le Roi No. 2 (£5), British Columbia	11 3	5 0
Mexico Mines of El Oro, Mexico	7 17 6	7 0 0
Nechi (Pref. 10s.), Colombia	12 6	8 9
Oroville Dredging, Colombia	1 8 9	1 7 6
Plymouth Consolidated, California	1 3 9	18 9
St. John del Rey, Brazil	18 9	16 3
Santa Gertrudis, Mexico	1 17 0	1 0 6
Tomboy, Colorado	16 6	10 0
RUSSIA:		
Lena Goldfields	1 11 3	15 0
Orsk Priority	15 0	10 0
INDIA:		
Balaghat (10s.)	4 9	8 0
Champion Reef (2s. 6d.)	4 3	2 3
Mysore (10s.)	1 5 0	13 9
North Anantapur	4 6	4 0
Nundydroog (10s.)	17 6	5 3
Ooregum (10s.)	14 3	13 3
COPPER:		
Arizona Copper (5s.), Arizona	1 16 3	2 1 3
Cape Copper (£2), Cape and India.	2 7 6	1 0 0
Esperanza, Spain	5 9	5 0
Hampden Cloncurry, Queensland	17 9	12 6
Mason & Barry, Portugal	2 3 9	1 10 0
Messina (5s.), Transvaal	5 0	5 6
Mount Elliott (£5), Queensland	4 5 0	1 5 0
Mount Lyell, Tasmania	1 5 3	1 0 0
Mount Morgan, Queensland	1 2 6	17 6
Mount Oxide, Queensland	8 0	3 9
Namaqua (£2), Cape Province	2 0 0	1 7 6
Rio Tinto (£5), Spain	50 10 0	29 0 0
Russo-Asiatic Consd., Russia	1 2 6	13 3
Sissert, Russia	1 15 0	11 3
Spassky, Russia	1 12 6	17 6
Tanganyika, Congo and Rhodesia	4 5 0	1 12 6
LEAD-ZINC:		
BROKEN HILL:		
Amalgamated Zinc	1 6 0	1 2 6
British Broken Hill	2 0 0	1 10 0
Broken Hill Proprietary (8s.)	2 4 3	2 10 0
Broken Hill Block 10 (£10)	1 1 3	1 1 3
Broken Hill North	2 8 9	2 5 0
Broken Hill South	2 2 6	2 2 6
Sulphide Corporation (15s.)	1 2 0	15 0
Zinc Corporation (10s.)	19 3	13 9
ASIA:		
Burma Corporation (10 rupees)	13 7 6	12 6†
Russian Mining	18 9	10 0
RHODESIA:		
Rhodesia Broken Hill (5s.)	14 6	10 9
TIN:		
Aramayo Francke, Bolivia	3 17 6	3 7 6
Bisichi, Nigeria	15 3	10 0
Briseis, Tasmania	4 6	4 0
Dolcoath, Cornwall	8 6	2 6
East Pool (5s.) Cornwall	17 9	10 3
Ex-Lands Nigeria (2s.), Nigeria	3 6	2 6
Geevor (10s.) Cornwall	1 5 0	10 0
Gopeng, Malay	1 16 9	1 15 0
Ipoh Dredging, Malay	1 0 0	15 0
Kamunting, Malaya	2 6 3	2 10 0
Kinta, Malaya	2 12 6	2 0 0
Malayan Tin Dredging, Malay	2 1 3	1 13 9
Mongu (10s.), Nigeria	1 4 0	18 9
Naraguta, Nigeria	16 6	11 3
N. N. Bauchi, Nigeria (10s.)	8 0	4 3
Pahang Consolidated (5s.), Malay.	15 9	10 3
Rayfield, Nigeria	14 9	8 0
Renong Dredging, Siam	2 13 9	1 15 0
Ropp (4s.), Nigeria	1 4 0	8 9
Siamese Tin, Siam	3 2 6	3 2 6
South Crofty (5s.), Cornwall	1 1 3	11 9
Tehidy Minerals, Cornwall	1 8 9	15 0
Tekka, Malay	4 5 0	1 2 6§
Tekka-Taiping Malay	6 7 6	1 2 6§
Tronoh, Malay	2 8 9	1 7 6

* £4 shares split into 8 of 10s. each. † 10-rupee shares of Indian Co. § New shares. ‡ £1 shares split into 4 of 5s. each.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

ORIGIN OF PRIMARY ORE DEPOSITS.

At the October meeting of the Institution of Mining and Metallurgy, Dr. J. Morrow Campbell read a paper on the origin of primary ore deposits, in which he laid stress on the functions of silicic acid as carrier of ore deposits, and giving his idea of the method of introducing oxygen and hydrogen into magmas. We give herewith an abstract of the paper.

Consideration of the subject commences at the stage when the present silicate crust of the earth was in the liquid state. The assumption of this condition is in conformity with the nebular theory of the origin of the earth, and also with the planetesimal hypothesis as outlined by Daly in "Igneous Rocks and their Origin." When the molten silicate layer first formed, it and the barysphere below contained no water. The water was all in the gaseous state. Since the present oceanic water, if spread uniformly over the solid surface of the earth, would cover it to a depth of two miles, the atmospheric pressure at the period referred to was equal to a hydrostatic head of over 10,000 ft., or the weight of 4,000 ft. of sedimentary rocks, 300 times as great as it is at present. Such pressure caused great modifications in chemical affinities and physical phenomena. The bearing of this on silicic acid and hydrous silicates is important.

Many geologists assume the existence of two primary magmas: the granitic and the basaltic. These may reasonably be assumed to have resulted by the differentiation of a single primeval magma of andesitic or dioritic composition.

The process of crust formation is pictured by the author as follows. Solidification commenced at the surface by radiation of heat as ice does on water, but with the difference that the solid was heavier than the liquid and, when broken up by movement, sank and was resorbed. This cycle of crust formation, foundering, and remelting proceeded until the liquid was greatly reduced in temperature throughout, and ceased only when viscosity prevented further foundering. At this stage the temperature gradient in the silicates was reduced to an order of magnitude comparable to that in the solid crust at present. Owing to the low conductivity for heat of solid silicates, it is hardly credible that a gentle temperature gradient could have been established in any other way. The molten silicates absorbed water from the atmosphere, but at what temperature this commenced cannot be stated. This water is believed by the author to have combined as hydroxyl and not to have been simply dissolved as a gas. The distinction is probably fundamental. Oxygen was absorbed also. The masses that froze became larger and larger as the temperature of the molten layer fell, and they sank to greater and greater depths before being entirely resorbed. In this way the molten silicates were constantly kept in a state of agitation while oxygen and the elements of water were disseminated to great depths. This process must have extended over a long period, but, even at its close, the capacity of the silicates to absorb water was not nearly satisfied. Finally the crust became permanent and the widespread absorption of water ceased.

Experiment proves that granite and basalt when heated together melt and form a homogeneous mixture from which hydroxyl is expelled as water. Phenomena in nature, however, lead us to believe that granite and basalt are not miscible if fused under pressure with a few per cent of water present.

Combination of water with silicates under pressure is regarded as the cause that brought about the gravitative segregation of the primeval magma into a dense basaltic layer below and an acid granitic layer above, owing to the immiscibility of the two. This could only have taken place after the agitation caused by crust-foundering ceased. The top portion of the permanent crust was probably intermediate in composition. Below this, granite developed, and further down basalt, but the latter must have remained liquid for a long time.

Acid magmas during consolidation give off an acid mother-liquor which carries all the ore minerals that were disseminated through them. It is concluded, therefore, that on consolidation of the primeval granite vast quantities of ores must have been discharged at and near the surface. These were rapidly denuded and dispersed in sediments and in solution. The presence of gold and other metals in sea-water may be due very largely to this cause.

The crust of the earth did not develop peacefully, however, for it was contorted and fissured, large quantities of basic lava being extruded. The early sediments were resorbed, with their ores, in magmas perhaps repeatedly, and as often underwent segregation. To this cause in all probability is due the present erratic distribution of primary ores. Primary ores are defined as those which are derived directly from rock magmas or magmatic liquids and have not undergone any essential change since their segregation or deposition. Those ore deposits which are formed by segregation of dispersed primeval ores and deposited at higher levels may also be regarded as primary.

Since the segregation of ores from rock magmas is part of the general process of magmatic differentiation, the latter problem must be considered. Rock magmas are generally regarded as forming from solid material at depth in the crust owing to an increment of heat. There are various theories as to the source of this heat. Some attribute it to mechanical causes, others to the oxidation of elements introduced from the barysphere, and still others to the action of water. Some of the phenomena of volcanism are reviewed by the author, and they are regarded as being in some measure inconsistent with the mechanical theory. The oxidation of elements would be satisfactory if a reasonable explanation of the source of oxygen was furnished. The author favours the introduction of water as explaining phenomena most readily, and believes the water to be of meteoric origin. The weight of evidence proves lavas to give off either water or its elements, and it is argued that this water is the result of the breaking up of hydroxyl groups in silicates on the relief of pressure. Rock magmas develop from matter of igneous origin primarily, though they may absorb sediments subsequently. On cooling they give off large quantities of aqueous liquid, and it is unreasonable to suppose that the original igneous material from which they formed could have held in combination or solution a quantity of water or its elements much larger than can the solid products of the differentiation of the magma formed from it. It seems evident, therefore, that rocks yielding magmas must have received from some source an accession of water between the original solidification of the crust and their subsequent liquefaction. Pools of molten basaltic magma high above their melting-point could not possibly exist in the crust for long periods.

Water in either the liquid or gaseous condition at atmospheric pressure has practically no action either physical or chemical on silica at any temperature. Silica and water heated together in a sealed tube to 200°C form a homogeneous liquid which on cooling yields crystals of quartz. There is good reason to believe that water under pressure and at moderate temperatures combines with silica to form silicic acid, $SiO_2.2H_2O$, or $Si(OH)_4$. Silicates are comparatively simple compounds, since the silicon atom in them appears to be capable of union with another silicon atom only through the medium of oxygen atoms, never directly. Silicates are known containing a minimum of one to six silicon atoms per molecule, and the corresponding silicic acids in their simplest forms are chain compounds which differ from one another in series by SiO_2. It is conceived that excess of silica and water form poly-silicic acids and that the greater the pressure the longer the chain may be. With rising pressure, ortho-silicic acid takes up silica to form the poly-silicic acids, and with falling pressure these long-chain molecules give off SiO_2, which crystallizes from this medium as quartz down to a temperature of about 180° C, below which silica in cryptocrystalline form develops, and at still lower temperature so-called hydrated (amorphous) silica, of which opal and sinter are examples. This so-called water in opaline silica is not completely expelled till about 500° C, and there can be little doubt that it is combined as hydroxyl. It is reasonable to suppose that all the "water" in magnetic mother-liquor is combined as hydroxyl with silica. It is not only in magmatic liquid that silicic acid is found, however, for in sediments we know that cellulose is replaced by hydrated silica. Nor is silicic acid confined to the mineral kingdom, for both plants and animals secrete hydrated silica from solution in their juices. "Water" in magmas, present as hydroxyl, does not perform an acid but a basic function, for its hydrogen takes the place of metals (usually alkalies) in silicates either wholly or in part. Water absorbed by a magma appears to combine in silicates as hydroxyl, displacing oxides the affinity of which for silica is weak.

The primeval magma is assumed to have contained about 60% of combined silica, and at first to have been anhydrous and homogeneous. Absorption of water is supposed to have resulted in the formation of silicic acid and the liberation of oxides such as FeO. Silicates and alumino-silicates of potash are known to be readily soluble in silicic acid, and those of soda, lime, and magnesia progressively less soluble. The silicic acid is assumed to have leached out the potash-bearing silicates most largely, and it would appear that this solution is immiscible with a melt of basic felspars and ferro-magnesian minerals. Since the former is lighter, it formed a layer gravitatively above the latter, hence granite developed above and basalt below. These two rocks are of world-wide distribution, and this feature seems to be explicable only on the assumption of a great split in a world-enveloping magma of uniform composition. The formation of local magmas of greater or less extent subsequent to the solidification of the crust appears to be due to absorption of water principally by basaltic material. Magmatic stoping probably on a large scale followed, as described by Daly, and when these magmas underwent differentiation the rocks they yielded and the ores they expelled were determined to a large extent by the nature of the sediments absorbed. Anorthosites below and alkaline rocks above, for example, would be the result of the absorption of limestone. The origin of the great variety of rarer igneous rocks can be explained in this way. Basaltic magmas that have not absorbed sediments would on differentiation probably yield diorite above and peridotite below. The further action of water on peridotite below its fusing point is to convert it into serpentine and, if fused, the silicates are broken up completely, the silica removed, and ores such as ilmenite, magnetite, and chromite remain behind, material so little resembling plutonic rocks in general that their igneous origin has been questioned. Ore minerals are to a large extent leached out of the primary magma apparently by silicic acid. Metals (gold and bismuth), oxides (of tin and tungsten), and sulphides (of molybdenum, bismuth, iron, copper, zinc, lead, antimony, and arsenic) appear to be soluble to a greater or less degree. Platinum appears to be quite insoluble, chromite and ilmenite very sparingly soluble, borates and fluorides soluble. In the basic fraction are found either interspersed or segregated in masses the residue of ores not dissolved in the acid fraction.

The first group of ore minerals to develop from an acid magma are molybdenite, tungstates, cassiterite, native bismuth, and bismuthine. These are apparently homogenetic, either all are of pneumatolytic origin or none is. Cassiterite and wolfram are typical of the group. They have been regarded for 50 years as of pneumatolytic origin; that is, they are supposed to have been present in the magma as fluorides and to have been given off as such along with water above its critical point. Tin fluoride boils at 705°C and tungsten fluoride at 19°C. As gases they would be expelled either owing to reduction of pressure or solidification of the solvent. The conditions of occurrence of the ores indicate they were not released in this way. The difference between the boiling points of the fluorides is quite inconsistent with cassiterite and wolfram developing in contact with one another. When cassiterite occurs in veins in sediments there is no indication that the walls of such veins have been subjected to a temperature in any way approaching the boiling point of tin fluoride. The association of tourmaline and fluorite with the high temperature ores is supposed to support their pneumatolytic origin. Certain deposits do not contain either tourmaline or fluorite. Tourmaline accompanies gold, pyrite, hematite, chalcopyrite, and tetrahedrite, just as fluorite accompanies galena, and none of these minerals is of gaseous origin. All evidence in support of the pneumatolytic origin of the high temperature ores breaks down when critically examined; the theory should therefore be rejected. Quartz is the invariable companion of these ores, and the evidence in nature is overwhelmingly in favour of their having been transported in silicic acid solution and deposited therefrom on reduction of temperature and pressure.

In primary gold deposits quartz is always present. Gold and quartz are proved to have been deposited in certain cases from the same solution. Maclaren refers to silicate of gold. There is good reason to believe that silicic acid is the vehicle that carries gold. The fact that extensive auriferous alluvials are not found in beds older than Tertiary leads us to believe that leaching of gold from them explains their absence. The conditions of formation of silicic acid in the strata point to it as the only substance capable of dissolving out gold always present in older rocks at some period and only rarely present in less deeply buried strata.

Primary deposits of copper, zinc, lead, and antimony are almost invariably accompanied by quartz, and the phenomena of their occurrence lead to the belief that the sulphides of these metals were transported in silicic acid solution. The author believes it was a case of chemical combination rather than of simple solution. A parallel to these hypothetical silicate-sulphide molecules is found in the mineral lazurite, which is a double silicate-sulphide of sodium and aluminium.

The author has for some time regarded the temperature of deposition of tin and tungsten ores as being lower than is generally accepted and also the range of temperature through which they are released from solution as narrower. At Zinba mine in the Tavoy District of Burma there are found rounded masses of bismuthine enclosed in molybdenite, wolfram, fluorite, and quartz, which were almost certainly molten. As the same mineral is found in the same vein only a few feet higher up in normal crystalline form, it appears that the melting point of bismuthine is the maximum temperature at which this class of ore develops. The melting point of Bi_2S_3 appears to be unknown, and its determination presents serious difficulty as it dissociates into BiS and S. The generally accepted cause of the deposition of ore minerals is falling temperature, but there certainly are other contributory causes, and release of pressure is probably the most important. The phenomena of the occurrence of tin and tungsten ores are quite inexplicable on the assumption that loss of heat is the only determining factor. Precipitation by reaction with substances in the walls of fissures is an important but accidental cause of ore deposition.

Vein fissuring is illustrated by the multiple type of tin and wolfram veins in Burma. They are numerous and lie in patches circular or oblong in outline and seldom as much as 2,000 ft. across. When occurring in sediments they may extend as much as 1,000 ft. above the granite periphery. At the surface the veins are usually very numerous, but they diminish in both number and width at depth. This type of fissuring could be caused only by expansive force within the magma, not by contraction. The length of the fissures is often less than their vertical height above the granite periphery; therefore the causative force must have acted at or near the surface of the granite in a very small area and was of very great intensity. These fissures were opened up suddenly and remained open until filled by solids. The theory that veins were opened up slowly by the force developed by the crystallization of ores in initially very narrow crevices is entirely unacceptable in this case. The cause of fissuring is best explained by W. H. Goodchild's work, the pressure caused by the increase in solid specific volume of minerals in a cooling magma. This is irresistible, and is coincident with the segregation of the mother-liquor. In amount it is so great as to more than counterbalance the contraction taking place on granite assuming the solid state. The fact that we find several successive series of fissures in the same area is consistent withthe wave-like mode in which the effect of the above force would develop. Fissures of the first series were filled instantly with magmatic liquid and rapidly sealed with solids deposited therefrom. The force accumulated until another series was formed, and these were similarly filled. This type of fissure appears to be due to the percolation of meteoric water down to the magma in the centre of areas where fissures develop. Another type of vein, which is of great length, striking parallel to the axis of the granite ridges, seems to be the more normal, but these are rare in Burma. Such of these as occur have, as might be expected, been reopened repeatedly and contain a great variety of ore minerals.

The author proceeded to consider the upward succession of ore minerals. Lindgren's classification into, (1) high temperature deposits, (2) deposits formed at intermediate depths, (3) deposits formed near the surface, is approved by the author except in so far as too much importance seems to have been attached to accessory minerals. For example, chalcopyrite-tourmaline deposits are classed as high temperature, whereas the same ore without tourmaline is regarded as having formed at intermediate depth and presumably at lower temperature. There is no reason to believe that the presence in a solution of the radicles going to form tourmaline would raise the temperature at which chalcopyrite develops. When a fissure opens it is filled with magmatic liquid, and the temperature of the walls, except in the immediate vicinity of the magma, will vary according to the local temperature gradient. At all points in the fissure the liquid will be slightly hotter than the walls, but, considering the probable slow rate of flow of the liquid and the enormous volume of wall-rock, the temperature of the latter could not be raised to any material extent. Near the periphery of the granite cassiterite develops at a certain temperature and continues up to a point in the vein where apparently the temperature of the solution no longer permits tin to remain in solution. The vertical extent of cassiterite in the vein thus seems to depend on the rate of loss of heat by the solution and will be controlled by the steepness of the temperature gradient in the strata. A gentle gradient should therefore favour persistence in depth. The Morro Velho gold mine in Brazil is an example of great persistence in depth, and there the temperature gradient is very gentle, 1°C per 140 ft. There appears to be a limit of temperature above which cassiterite is not deposited, and another below which it is insoluble. This range is apparently not over 100°C. The same applies to chalcopyrite, blende, galena, etc.; each appears to have its own range of temperature deposition, and these are narrow in each case, not over 50°C and probably much less. At Morro Velho 6,400 ft. represents a temperature range of only 47°C. There are few chalcopyrite deposits that persist for a vertical depth of 2,000 ft., and the temperature range for that depth, with a normal gradient, is 20°C. Pyrite is peculiar in the respect that it may be deposited at any temperature, but it may move in other than silicious solution. Deposition of the sulphides of zinc, lead, antimony, and mercury takes place at successively lower temperatures than copper, and therefore they are found at shallower depths or at greater distance above the magma from which they emanated. The fact that quartz is a common companion in veins of all these ores leads the author to believe that silicic acid may be the solvent that carries them all upward. Mercury possibly may be an exception, for it is well known to be deposited by thermal waters carrying H_2S, alkaline sulphides, and borates. But the same springs are also silicious, so that sulphur may be no more necessary for its solution than the borates that frequently accompany it. The evidence of hot springs must be accepted with great caution, because the ores they deposit and the compounds they carry in solution may not have originated in magmas but be dissolved out of deposits traversed on their way upward. It is necessary, however, to attach great importance to the fact that so many hot springs are silicious. Silica and water are the only invariable products secreted by the magmatic mother-liquor throughout the whole of its upward passage, and no other substance appears to be invariably present in it.

In introducing the paper at the meeting, the author called attention to the fact that the mode of occurrence of ore deposits is irreconcilable with deposition from simple solution by loss of heat, but more consistent with liberation in insoluble form by the dissociation of soluble complex molecules breaking up by relief of pressure. No substance soluble in a liquid at a given temperature becomes suddenly quite insoluble on a slight fall of temperature. If deposited from simple solution, ore deposits should not end abruptly but taper off gradually and extend to the utmost limit reached by the solvent. Where there are high pressures in nature elevated temperatures also exist, and it is possible that in the past there has been confusion of the two. Just as pressure is essential for the development of silicic acid, and release of pressure determines its dissociation, it appears not improbable that in the same way pressure may be a more important factor than temperature in both the solution and deposition of primary ores.

WORK OF THE GEOLOGICAL SURVEY DURING 1919

The Summary of Progress of the Geological Survey during 1919 contains some notes on the examination of lead, zinc, and copper mines, and on the boring for oil at West Calder, Midlothian. We quote these notes herewith.

The Northumbrian area was examined by Dr. Stanley Smith, the rest of the Pennine Chain by Mr. Carruthers. Throughout this region, the great majority of the productive veins are in Carboniferous Limestone and Yoredale strata, though a few traverse the Millstone Grit also. They are characterized by a comparatively rapid impoverishment in depth, generally because the fissures pinch out, but occasionally on account of replacement by other minerals. It is rare to find a vein carrying commercial quantities of ore below 100 fm., and it is not surprising to find that after centuries of working, most of the mineral fields, taken as a whole, show signs of exhaustion. There are notable exceptions, however. The famous flats of the Boltsburn mine, in Weardale, discovered 27 years ago, are still in full work. They appear to be metasomatic replacements of the limestone, parallel to, but rarely in contact with, a thin vein, which has presumably acted as a feeder.

The Alston Moor country continues to be an important producer, especially for zinc blende, of which considerable reserves exist. Metasomatic flats are found here also.

Most of the Derbyshire mines, once so numerous and active, closed down many years ago. Mill Close mine, marked by immensely rich chamber-deposits on either side of the lode, is still in active work. The headings are now far under the Yoredale Shales, nearly two miles from the limestone outcrop. Most of the innumerable veins scattered over the limestone massif in this country are probably exhausted, but if some efficient means could be devised to cope with the heavy underground water, some of the great rakes, now drowned out, might again produce galena in quantity. Interesting evidence as to the date of the Derbyshire ore deposits is provided by the small lead and copper working at the Snelston mine, near Ashbourne. The ores are found in a fault bringing down Keuper Marl against Carboniferous Limestone, so that, here at any rate, the mineralization seems to be definitely post-Triassic.

The occurrences of galena and blende in the Carboniferous Limestone and Chert series of Flint and Denbigh were examined by Mr. Bernard Smith, with a view to bringing up to date the detailed account given in the Memoirs on the Geology of Flint, Mold, and Ruthin (1890) and the Geology of the Coasts adjoining Rhyl, Abergele, and Colwyn (1885). The abandoned mines near Minera, in ground recently surveyed, were also studied. The chief mines still in work are in the Halkyn District, but others are ready to reopen in both this and the Holywell districts if deep drainage can be secured or labour conditions permit. In depth the lodes appear to carry a higher proportion of blende than galena. The future development of this region depends upon a successful unwatering of the ground. The old Halkyn tunnel, driven southward as far as the Llyn-y-pandy lode, about four miles south of Halkyn, at approximately 200 ft. above sea level, no longer serves the purpose, for most of the mines unwatered have been worked down to, or below, its level. Further work in these mines entails costly pumping. It is now proposed to carry the Milwr or sea-level tunnel, which has already proved several of the lodes in depth in the Holywell area, southward into the Halkyn district, and extend it eventually into the Llanarmon field. It is hoped that in that area numerous veins, which have yielded richly in the past, may be found to be prolific in the eastern parts of their courses. The southern extremity of this tunnel is now at the northern boundary of the Halkyn mines district drainage area, and about 200 ft. below the old tunnel. During the closing stages of the war a pumping scheme, financed by the Government, was commenced at North Hendre mine, to unwater several bearing lodes below the Halkyn tunnel level, but this scheme is in abeyance. Little is being done at the present time in the Minera district, chiefly owing to the fact that the great Minera veins contain blende, but little galena, in depth, and pumping charges are prohibitive.

In the Minsterley district of Shropshire the future of the mines depends upon deep drainage. Here the ores of lead and zinc occur chiefly in the Mytton beds overlying the Stiper Stones quartzite and beneath the Hope Shales, all of Arenig age. The Leigh adit level (399 ft. O.D.) has been completed as far as the Milne shaft in the Hope valley, and is now being driven southward to cut a large series of veins formerly worked in the old gravels and grit mines. Should these prove to be rich beneath the old workings a promising future is assured for the Shropshire mines. For the Bog mine pumping has been proposed. At the present date the chief product of the district is barytes, got from shallow levels above water-line.

Mr. Smith also examined occurrences of lead and zinc ores in the Ordovician and Silurian rocks, near St. Asaph in Flintshire, Llansannan in Denbighshire, and Llanrhaiadr and Llangynog in Montgomeryshire. The Pennant mine, St. Asaph, is alone in operation.

Some scattered occurrences of copper ore were also investigated in Denbighshire and Shropshire.

The mines for lead, zinc, and copper in Cornwall, Devon, Somerset, Shropshire, Cheshire, Carnarvonshire, Merioneth, and Anglesey, were visited by Mr. Dewey.

In Cornwall and Devon, the lead and zinc ores occur principally in lodes which course north and south and frequently underlie east. They traverse slates and sandstones of pre-Devonian, Devonian, and Carboniferous age. Their gangue minerals consist of calcite, fluorspar, barytes, quartz, and chalybite. Galena and blende often form an intimate complex; but blende is the principal constituent in some lodes, as at Wheal

Sally and Wheal Alfred. In North Cornwall, where the lodes appear in and near flows of lava, galena is the dominant mineral; it is rich in silver and is frequently accompanied by the ores of antimony.

Lodes bearing galena and blende were formerly worked by open-cut pits sunk in the Carboniferous Limestone of the Mendips, and calamine and blende were also mined in the Triassic basic conglomerate on the flanks of those hills. No mines, however, are now in work, and the dumps have been thoroughly worked over.

Ores of copper, lead, and cobalt occur, mainly as carbonates, in the Keuper sandstone and conglomerates of Alderley Edge, Cheshire. In the underground workings the distribution of the ores is seen to be patchy. Percolating waters have impregnated the sandstone with ores in the neighbourhood of faults and the drainage waters in the mine are coloured a brilliant green by carbonate of copper. Rich impregnations of galena up to 3 ft. in length can be seen in several of the levels. The mineral envelops the grains of sand and even the pebbles of the conglomeratic beds. The normal ore consists of fine-grained sandstone with a cement of green and blue carbonates of copper.

At Grinshill and some other workings near Shrewsbury, copper ores have been mined in the New Red rocks and appear to be identical in mode of occurrence and of formation to those of Alderley Edge.

Near Llanrwst, in east Carnarvon, there is a large group of mines working lead and zinc ores, in most cases by day-levels above adit. The country rock is of lower Palæozoic age and is fissured by two sets of lodes which course either north and south or east and west.

These lodes, in many cases, are mineralized shatter-belts and consist of brecciated country-rock cemented together with calcite, galena, and blende. There are indications of a succession of minerals in the lodes from east to west. The Aberllyn lode consists mainly of brown blende in the form of shear lenticles, galena being rare. A little farther to the west galena forms the principal constituent with a calcite gangue, as at Parc mines; quartz as a gangue then appears at Old Llanrwst mine, where it forms a remarkable spongy mass of bipyramidal crystals embedding idiomorphic crystals of galena. Almost due north from these mines pyrites becomes an important accessory. At Cae Coch it is the principal ore and has been wrought.

In Anglesey metallic copper is still being obtained regularly from the drainage waters of the Parys Mountain mines by precipitation on scrap iron; but further mining is not at present anticipated. Some auriferous copper ore is being mined at Rhos-mynach, Anglesey, and from the old gold mines of Figre and Clogau, near Dolgelley. Zinc and lead ores are mined at Moelwyn and Bwlch-y-plwm mines.

In the Lake District, ores of lead, zinc, and copper are found in Lower Palæozoic strata. The veins around Keswick are in the Skiddaw Slates; those of the Greenside and Coniston fields are in the Borrowdale Ashes, while in the Caldbeck Fells, both rock groups occur, associated with a complex of igneous rocks. Most of the veins are filled with broken country rock, cemented with mineral matter. The leading constituents of the gangue are quartz and barytes, the latter, when in bulk, being restricted to the higher parts of certain veins. Some of the so-called lead lodes contain more blende than galena. Although there are numerous exceptions, copper veins usually trend east and west, hading south, while lead and zinc veins range within 45° either way of north and south, and dip to the east. Copper lodes are sometimes shifted by those carrying lead, while the latter are frequently displaced by barren east and west cross-courses. The chief ores now raised are those of lead and zinc. Over the whole area, as compared with the Pennines, the galena is notably rich in silver. The amount varies greatly, and seems to have some relation to the presence of barytes. In veins where barytes is abundant, as at Force Crag, the silver content is high, over 30 oz., while in lodes carrying little or no barytes, as at Thornthwaite and Threlkeld, it is low, about 10 oz. of silver per ton of pig lead. The only zinc ore of commercial importance is blende. When this occurs with barytes the difficulty of separation, almost insuperable in the old days, has now been got over by oil flotation. The Elmore plant at Force Crag gives a clean blende concentrate, while the crushed barytes is re-dressed and sold as barytes sand. The lead-zinc ore mines now active are Greenside, Thornthwaite, Threlkeld, and Force Crag. Brundholme in Glenderaterra valley has been reopened, while at Goldscope in Newlands Vale an attempt is being made to locate the intersections of the copper lode and Sealby's lead vein in the hope of proving an ore-body similar to that of the great lead bunch of the Goldscope lead vein. No copper ores are being raised at present, though Coniston, Goldscope, and Caldbeck Fells were large producers many years ago. The extensive dumps at Coniston have recently produced a few tons of sheet copper by an electrolytic process, but work is now suspended during reconstruction. The chief ore is chalcopyrite, which is associated with iron and arsenical pyrites. Secondary malachite and chrysocolla also occur, but not abundantly.

The bore in search of petroleum, ¼ mile south of the village of West Calder, Midlothian, has now reached a depth of 543 fathoms, and is the deepest bore which has yet been put down in the oil-shale series in Scotland. A small anticline occurs to the south-west of West Calder and the oil-bore has been placed approximately on the summit of this anticline, which is about ½ mile in diameter and gives place to synclines on the east and south. The important Calder fault has been traced on the east side of the anticline, but perhaps dies out as it runs south-westward, as the dislocation of the outcrops of the oil-shale seams cannot be of great magnitude. At a distance of about ½ mile to the south-west of the bore there are several small faults. The bore starts immediately below the Broxburn shale, which has been mined to the outcrop a short distance to the west. At a depth of 50 to 55 fm. it passes through an oil-shale which is recognized by the mining engineers of the district as the Dunnet seam. About 73 fm. from the surface there is another oil-shale, which is probably the Under Dunnet, well known in the adjacent district, but frequently not of economic value. Thirty fathoms lower down there is a light-brown fresh-water limestone, apparently 10 to 12 ft. thick. This may be the Barracks Limestone, though that bed is generally not well represented at West Calder. In other respects the upper portion of the bore does not differ from the sections recorded in other bores in the immediate vicinity. The deeper strata, however, have not been proved hitherto by boring at West Calder, and the new record is of interest, not only as furnishing evidence of the exact geological sequence, but as differing somewhat from natural exposures in the neighbourhood. The first recognizable horizon below the Barracks Limestone is the Burdiehouse Limestone, which was 15 ft. thick and was entered at 215 fm. It shows the usual characters, being a dark-coloured, fine-grained, fresh-water limestone. Between these limestones there are 110 fm., mainly sandstone with intercalations of dark shale, but, although a thin oil-shale was found at 188 fm., there is no indication of any deposit of economic interest, and in the Camps Shale position above the

Burdiehouse Limestone nothing of value was met with. For 63 fm. below the Burdiehouse Limestone there was a rather monotonous sequence of dark carbonaceous shales with a few beds of sandstone near the top, some marls, and a thin dark limestone. At 280 fm. a thick bed of greenish volcanic ash was encountered, and this persisted to a depth of 418 fm. As a whole this ash-bed was uniform in composition, but occasionally it had an admixture of dark shale, and at 375 fm. the rock-powder extracted from the bore showed traces of coal. The larger fragments in the ash were examined microscopically and proved to be olivine-basalt. From 418 to 433 fm. the bore passed through black shales, with a thin non-fossiliferous limestone of the type known in this district as a cement. There another basaltic ash-bed was proved which persisted from 433 to 489 fm. Apparently it was free from admixed sediment. Below this there were 7½ fathoms of vesicular dark green olivine basalt, in a single lava-flow so far as was ascertained. From the base of this lava at 497 fm. black shales with a few thin seams of limestone or cement extend to the bottom of the bore, a farther depth of 46 fm. The distance below the base of the Burdiehouse Limestone (217 fm.) is at present 326 fm., and is almost entirely occupied by black shales, basaltic ash-beds, and one lava-flow. None of the oil-shale seams that lie below the Burdiehouse Limestone, such as the Pumpherston, Dalmahoy, Wardie, and Coalheugh Shales have been identified, but this was not unexpected, as in no part of the surrounding country have they proved to be workable. From a geological standpoint the striking feature of the bore record is the general character of the sequence below the Burdiehouse Limestone. In the nearest available section, that seen in the Murieston Water from Harburn to Skivo (from 2 to 4 miles distant) the sequence at this horizon consists largely of sandstone, with one oil-shale (the Coalheugh Shale), a limited amount of black carbonaceous shale, and probably a few insignificant ashy beds. Three miles to the south, in the Cobbinshaw district, these lower beds have been proved by bores and are visible in natural exposures. In that district the Pumpherston shales are not workable, but there is a bed of volcanic ash, known as the Crosswood Ash, which may be on the same horizon as that which occurs in the West Calder bore. It is only 7 fm. thick, while in the bore under discussion there are 194 fm. of basaltic ash. At Crosswood also there is no lava-bed below the ashes. Other points of difference are that in the Cobbinshaw area there are frequent deposits of sandstone and shaly sandstone, a few thin encrinital limestones and intrusive sills of dolerite among the strata below the Burdiehouse Limestone, all of which are absent at West Calder, so far as the bore has yet proved.

OIL SHALES IN THE EASTERN TRANSVAAL.

In the August issue of the *South African Journal of Industries*, T. G. Trevor, Government Inspector of Mines, gives particulars of recent activities in connection with the development of oil shales in the Wakkerstroom district in the Eastern Transvaal close to the Natal boundary.

In 1913, E. H. Cunningham Craig was invited by the Union Government to report on the petroleum prospects in the Union of South Africa. His report was published in 1914 by the Government Printer, Pretoria, and is still procurable. (An outline of his conclusions was given in THE MINING MAGAZINE for April, 1914). After visiting all the known prospects of petroleum, natural gas, and oil shales in the country, Mr. Craig unhesitatingly condemned the chances of finding liquid oil in economic quantities on the ground that there were no suitable geological formations known for its generation or storage, with the exception of a comparatively small folded belt in the Prince Albert district, where the geological formation appears suitable, but where there is no other evidence of its existence, unless the peculiar veins of pseudo-anthracite in the region lying to the north of the folded belt be taken as such. He recommended the exploration of this region, though he admitted that the prospects were not very hopeful. Up to the present time, however, nothing more has been done in this direction. With regard to oil shales, Mr. Craig visited all the occurrences which were then known of these shales in the Ermelo, Wakkerstroom, Utrecht, and Impendhle districts, but, unfortunately, at that time these were not properly opened, and it was very difficult for him to see the deposits at all, much less at their best. He was, however, distinctly encouraging, and stated in his final paragraph that "all evidence to hand at present leads to the belief that an oil-shale industry has good prospects of proving successful, and I would urge that no effort should be spared to ensure that a fair test of its possibilities be made."

In the *South African Journal of Industries* for October, 1917, Dr. P. A. Wagner, in a paper on mineral oil, solid bitumens, natural gas, and oil shale, gave a further description of the local oil shales, together with a considerable amount of detail as to the contents in oil and the products of the fractional distillation thereof. He was also very favourably impressed with the prospects of an oil-shale industry being established. (This paper was quoted in the MAGAZINE for February, 1918).

Up to the last few months, however, nothing further has been done, but at the present time considerable activity is being shown in taking up farms on this line, and one company, the African Oil Corporation, is engaged in developing certain properties. This development is distinctly favourable, and Mr. Trevor proceeds to give details.

The property consists of four farms: IJzermyn No. 280, Goedgevonden No. 77, Kromhoek No. 76, and Virginia No. 371, all situated in the Wakkerstroom District. The farms lie in a line of about seven miles, and cover the northern slopes of the buttress of the great escarpment known as Castrol Nek Berg. This buttress juts out to the east from the main plateau of the high veld, and connects it with the Slangumpies Berg, at the same time forming the divide between the valleys of the Assegai and Pongola Rivers, which divide is also the political boundary between the Provinces of Natal and the Transvaal. The top of Castrol Nek Berg is approximately 7,000 ft. above sea level, but the normal height of the buttress is about 6,000 ft. This altitude may be taken as the height of the southern line of the farms, the northern line of which lies at the base of the berg, say about 4,600 ft. above sea level. The surface of the ground, therefore, drops about 1,400 ft. in a series of terraces and declivities from the south to the north, a distance of some two and a half miles. The whole of the farms lie on the Ecca Series of the Karroo rocks, the southern line possibly touching the upper Ecca in places and the northern the lower Ecca, the main formation being the middle Ecca. The formation lies very nearly horizontally, there being many places where the dip is too low to be observed, but the general dip appears to be about 4° W.S.W. The individual beds, therefore, outcrop nearly horizontally along the contour lines of the mountain. With the exception of two well-marked sandstone cliffs along the horizon of the main shale bed, prominent outcrops are the exception, the declivities being steep, grassy slopes. The cliffs, which in this formation usually mark the presence of igneous sheets, are absent. Such a sheet is, however, noticeable on the boundary of Kromhoek and Virginia overlying the shale, but over the greater part of the property conspicuous igneous rocks are rather remarkably absent.

The main shale bed outcrops between the two sandstone cliffs mentioned. This is at an altitude of about 5,100 ft. and 200 ft. above the bottom of the hill, where the camp is situated, and which is the highest point to which wheeled transport can conveniently be drawn. The outcrop of these shales has been opened at intervals of about 200 yards by short adit mouths, cut in sufficiently deep to show the full section of the shale with its roof and floor. These cuttings expose the outcrop for at least three miles. The outcrop runs about the middle of the farms, so that there is probably a width of approximately one and a half miles on the farms underlain by the main shale bed. The sections exposed in these cuttings—there are, the author thinks, twenty-two of them on Kromhoek and Goedgevonden which he inspected—are remarkably consistent, and average about as follows:

Roof—Solid sandstone.	
Oil shale—Grey laminated.........	16 in. to 27 in.
Blaes—Black (worthless)	24 in.
Sandstone (often absent)	6 in.
Oil shale—Grey laminated.........	3 in. to 12 in.
Coal—Very bright (good)	2 in.
Floor—Massive sandstone.	

Between the floor and the roof there is, therefore, about 60 in. to 70 in. of bed to be taken out, of which some 24 in. is shale. There should be no difficulty in separating this shale, as it is easily differentiated from the blaes and the sandstone, and the holing can be done in the blaes and the roof and floor shale taken out separately. The mining will be exactly similar to such coal mining as is done at the Hlobane Colliery or at the Natal Ammonium, and at present prices should not cost more than 4s. per ton broken. As three tons will have to be broken, however, for each ton of shale won, mining costs may be roughly estimated at 12s. per ton of shale hauled.

There are no signs of any important faults or igneous intrusions on Kromhoek, where the main section of the property lies, and where it is intended to install the works. The idea is to work this section from a self drainage drive put in up the dip from a transverse valley. This drive will develop about one square mile of ground, one side and two half sides of which are exposed in the outcrop cuttings; the shale in the interior has been tapped by two bore-holes, and is claimed to be of equal quality with the outcrop. Allowing that the shale measured *in situ* gives 17·6 cubic feet to the ton, then the yield of shale would be 200 tons per inch per acre, or in the observed width of 24 in. say 3,000,000 tons per square mile. It is obvious that the quantity of shale on the property is more than enough to justify the erection of a modern plant. The working conditions are ideal. The bed, outcropping as it does about 200 ft. above the terrace below, gives every facility for working entirely by gravitation. The locality is absolutely healthy, and there is water in abundance.

The actual distillation value of the shale is difficult to determine until a practical test on a working scale has been made. The results of eight samples and assays taken by the Central Mining and Investment Corporation, Ltd., gave on Kromhoek 25 gallons per ton from the upper shale and 14 gallons per ton from the lower shale, over a total width of 30 in.; while on Goedgevonden the results of seven samples over an average width of 31 in., 23·8 gallons were obtained from the upper shale and 18·1 gallons from the lower shale. On the other hand the tests made on the property by Mr. Mills Davies, the consulting engineer, averaged over 30 gallons per ton over 21 in. Probably this difference was due to the lesser width taken by him. A bulk sample of 60 tons is now on its way to Glasgow for a practical test both for crude oil product and for refining. When the results of this are known detailed calculations as to the profits accruing from working the shale will be possible, but it is believed that a profit can be made of £2. 10s. per ton of shale.

As similar shales are known to stretch intermittently from Mooifontein No. 287, in the Ermelo District, to the Impendhle, in Natal—a distance of not less than 200 miles along the outcrop—it is highly probable that if this oil corporation is successful a large industry may result even along the outcrop, and later it may be found worth while to tap the shales by means of shafts over the main area of the high veld.

Two bore-holes have been put down to prove the shale on Kromhoek. One of these was carried to 514 ft.; it started at an aneroid level of 4,900 ft., passed through the shale at 90 ft., at 200 ft. it traversed 1 ft. 9 in. of good coal, at 374 ft. it penetrated 4 ft. 4 in. of coal, also said to be excellent, at 406 ft. it again passed 1 ft. 9 in. of coal, and at 490 ft. disclosed 4 ft. 6 in. of coal. These beds are all known in the outcrops and appear to be quite up to the ordinary South African standard, though they have not been developed.

Though Kromhoek is only 13 miles by map from the railway at Wakkerstroom, yet the configuration of the country is such that to get there by road necessitates going round by Castrol Nek and Joubert's Hoogte, a distance of not less than 35 miles. The author is informed, however, by the Director of Roads and Bridges that the Provincial Government are now surveying a road from Naauwgevonden past Kromhoek, and have £3,000 ready to put into it. This road will bring Kromhoek to within 17 miles of Wakkerstroom, and it should be ready by next year, which is the earliest time by which the company's machinery can be expected to arrive. It is the intention of the company to put up a unit capable of treating 300 tons of shale per day, and this will give an output which, when packed, will not weigh less than 40 tons per day.

Diamond-Drilling at Le Roi No. 2.—In the *Engineering and Mining Journal* for September 25, P. S. Couldrey and E. H. S. Sampson give some details of the diamond-drilling work at the Josie and other mines belonging to the Le Roi No. 2 Company. Ever since Alexander Hill & Stewart took over the management of this company, after the Whitaker Wright collapse, the disclosure of new bodies of ore has been due to the well-directed diamond-drilling campaign, as has been recorded on numerous occasions in the MAGAZINE.

In the Josie mine the diamond-drill has been in almost constant use for nearly twenty years. The characteristic ore of Rossland is a gold and silver-bearing pyrrhotite associated with chalcopyrite. The gold content of the ore has always been the principal value, and of late years the copper content has dropped so low that direct smelting is very difficult. This ore occurs in veins more or less nearly parallel to one another, running roughly east and west. There are several veins in the Josie mine, but those referred to in this article are known as the Annie, North Annie, Hamilton, and No. 1.

The formation is, for the most part, a very hard augite-porphyrite, with patches of diorite-porphyrite and grano-diorite, giving place at the north end in depth to a silicified stratified rock, and at the south end to a porphyrite-monzonite. Numerous dykes running approximately north and south cut across this formation at frequent intervals, interrupting and in some cases faulting the ore-bodies. These dykes are roughly divisible into two classes, micaceous and non-micaceous. The former are distinguishable by the prevalence of biotite mica associated with orthoclase or plagioclase felspar. The largest and most important of the micaceous dykes is known as the Josie. This varies from 60 to 100 ft. in width. It faults the ore a distance of 350 ft. horizontally and probably about 200 vertically, though the amount of vertical throw is not yet clearly established. Mineralized zones frequently occur at planes of contact of the various formations. The non-micaceous dykes are usually hornblende associated either with orthoclase or plagioclase felspar, and as a rule are much harder than the micaceous variety. An exception to this rule is the dyke locally known as the porphyry dyke, which is traceable from the surface to the 1,300 ft. level, splitting into four or five branches as it goes downward and northward. Accompanying this dyke is another one known as the vitreous dyke. Where these two dykes cut across the Annie and North Annie veins the values immediately west of the intersection are invariably poor as compared with those to the east, but with the other veins no such change is noticeable, although an enrichment between the forks of the dyke has been observed on the Hamilton vein. The porphyry dyke interrupts all veins without faulting any.

An interesting dyke of the non-micaceous variety, and one which forms a veritable underground landmark, is locally known as the white dyke. This has much the appearance at first sight of a brecciated vein running north and south. It is traceable from the surface to the 900 ft. level, and it is noticeable that large boulders of the same material have been found several miles away. It consists of characteristic angular fragments of white quartz associated with other rocks, such as quartzite, gneiss, and syenite, many of which are entirely foreign to the neighbourhood, embedded in a dark olive-green or almost black matrix of spessartite in which large crystals of hornblende are often apparent.

In addition to the north and south dykes proper there are tongues of apparently altered diorite-porphyrite parallel with certain of the veins. These are usually spoken of as "following dykes," though this may be, geologically speaking, a misnomer. Two such dykes, one micaceous and the other non-micaceous, are found interlaced with the ore in the No. 1 vein, and though they are easily distinguishable the result is somewhat confusing, as the ore is found not only under or over but in both positions, and even between them. At the contact of the following dykes with the regular pyritic vein matter exceptionally high values in free gold are sometimes found, usually in the presence of crystals of arsenopyrite, antimonite, and, most noticeable of all, molybdenite. Precisely how this enrichment occurred, and whether of primary or secondary origin, is a matter for conjecture. Good gold values are sometimes found also near north and south mica dykes, for example, under the tramway dyke, in the under or western side of which both the Annie and North Annie veins have "bunched up" and widened out considerably. The north and south dykes almost invariably dip at steep angles, sometimes being quite vertical, an exception to this being the "H" dyke, which dips flatly to the west, interrupting all veins without faulting, but being itself faulted at certain points. The veins themselves dip in a northerly direction at angles varying from 50 to 80 degrees.

Such a complex formation produces at once the opportunity and necessity for rapid exploratory methods. In driving along any of the above veins a dyke will be encountered and crossed. Provided ore is not immediately found at the crossing-point, diamond-drilling can at once be employed to discover either the faulted portion of the same vein, or in the case of a non-faulting dyke, to explore for ore in the parallel vein. If this is successful, the exploratory driving can be transferred to the second vein, and when this work has advanced sufficiently far ahead a second hole can be put back across the track of the first vein, and vice versa. In this way the shortest distance to ore can be ascertained, and by inclining the holes upward or downward, and fanning them out horizontally, the extent of the shoots can be anticipated within reasonable limits. The majority of the holes drilled in the Josie are horizontal or nearly so, and very little drilling is done in the dykes themselves, as this would be both non-productive and difficult, on account of the broken nature of the ground. The augite-porphyrite, on the other hand, though hard, gives excellent cores.

Coal Veins in Peru. — At a meeting of the Mining Institute of Scotland held on October 9, William Campbell read a paper on the coal veins of Peru. These are the coals usually supposed to be allied to asphaltite, and in some cases contain vanadium.

In the province of Yauli, department of Junin, there are two distinct series of these veins. This province lies on the eastern slope of the Andes, and the veins occur in mountains at an altitude varying from 12,000 to 16,000 ft. The Central Railway of Peru, which crosses the Andes at an altitude of 15,865 ft., passes right through the department and crosses the veins which strike from east to west.

The coal veins are of two distinct series, which are about 20 miles apart. The first might be called bituminous and the second anthracite. The first of the series is near Huari, and may be called the Huari Series. Huari is a small native town on the Central Railway. From here the railway follows the valley of the River Montaro to the interior and has its present terminus at Huancayo. The series is made up of three distinct veins or fissures, running parallel to each other and not more than 100 ft. apart. The veins cut the limestone at nearly right angles to the bedding-plane, and have a dip of from 60° to almost vertical. They are clear and well-defined fissures, and they vary from 12 in. to several feet in width. The outcrops are also well defined and can be traced on the surface for long distances. With regard to values, they behave in exactly the same way as mineral veins, the coal occurring in irregular lenticular masses in the vein, and quite often barren portions are encountered. A vein will sometimes be found to carry coal for a long distance at a width of from, perhaps, 2 to 3 ft., when it may suddenly open out into a great mass, termed a "bolsonada." These deposits vary in width from 20 to 45 ft. Veins are sometimes also known to "manto," that is, the coal from the vein will sometimes be spread in or injected between the bedding of the limestone. A manto may, therefore, be defined as being a seam or bed, but this, unlike ordinary coal seams, is irregular in thickness and liable to be cut out suddenly without being intercepted by either dyke or fault. Mantos are always dependent on the veins, however, for enrichment. The sides of these veins are clean, and limestone is the country rock ; where any following is observed it has the appearance of black shale. This is hard, but when broken is found to be an impregnated limestone. Coal is mined at many points along the outcrop of these veins, but generally in small quantities to suit local needs. At Huari, Chucho, and Sorao, however, organized mining companies are at work mining coal in a systematic way. It makes a splendid house coal, but is also used, with a mixture of 50% of anthracite from the other series mentioned, for making blast-furnace coke. The coal burns easily, with plenty of flame, and gives off much smoke and a great amount of oil or pitch; indeed, when burning in an open grate this substance will quite often be found dripping on to the hearth. In actual mining, owing to the soft nature of the coal, a great deal of dust is made, and where the mines are dry it is highly inflammable. So long as the tallow candle or oil lamp was used for lighting purposes no explosions occurred, but since the introduction of calcium carbide as an illuminant explosions have been quite common. The dust is so inflammable that the flame from a carbide lamp will ignite it. The origin of these coals has never, to the author's knowledge, been discussed, but he believes that they are not of vegetable origin. He considers that these ashphaltites may have a close connection with some hidden oilfield. Oil shales, or supposed oil shales, are known to exist, and have recently been denounced as a mining concession. These shales, which on tests are said to have yielded 15 gallons of oil per ton of shale, are not true shales, but simply impregnated limestones.

The other series of veins is at Yauli, about 25 miles to the south-east of the former series. They also occur in the limestone and conform to the same rule as the others, having a strike from east to west. They are more irregular than those at Huari, and have an angle dip varying from the vertical to 45°. In this series coal is being mined at Rumichaca, and has also been mined at Llacsacocha, about 20 miles to the east on the same system. At Rumichaca 500 tons per month is mined, and, after being mixed with 50% Huari coal, is used for making blast-furnace coke. This coal is an anthracite, and is of little use for any other purpose than that mentioned. Samples of this coal yield the following analysis:

No.	Ash %	Volatile matter %	Fixed carbon %	Sulphur %
1	2·44	8·20	86·40	4·55
2	12·9	10·70	71·40	5·82
3	9·74	9·70	74·60	6·55

The veins being worked here vary greatly in value, and many barren portions are exposed. The workable portions vary from 3 to 4 ft. in thickness, and at one point where the vein has mantoed a large deposit of excellent quality has been discovered. At Llacsacocha the coal seems to have undergone further change, and, while the ash of all the coal contains vanadium, this contains probably sufficient to make the working for vanadium a commercial success. Two samples of this coal give the following analysis:

No.	Ash %	Volatile matter %	Fixed carbon %	Variation in ash %
1	12·8	10·5	76·7	3·1
2	2·8	9·0	88·2	15·0

Flotation at Mount Lyell.—The *Proceedings* for July, 1920, of the Australasian Institute of Mining and Metallurgy contains a paper by L. V. Waterhouse on the flotation plant erected by the Mount Lyell company for the purpose of treating ore from the Lyell-Comstock and North Lyell mines. The Comstock ore consists of chalcopyrite and pyrites, finely disseminated through a grey schistose gangue, which is at times much decomposed. Bands of hard quartzite carrying sulphides also traverse the ore-body. The North Lyell ore carries bornite, chalcopyrite, and pyrites in a silicious gangue, consisting mainly of a very hard quartzite and some schist. The ore sent to the flotation plant is of lower grade than the 6% ore sent to the furnaces in mixture with Mount Lyell pyritic ore. The following are typical analyses of the respective ores:

	Lyell-Comstock.	North Lyell
Cu%	2·6	3·5
Ag, oz.	0·23	0·7
Au, oz.	0·02	0·01
SiO_2%	46·0	66·0
Fe%	11·5	8·0
$BaSO_4$%	1·4	2·0
Al_2O_3%	1·55	7·7

For the year ended September 30, 1919, concentration results were as follow:

	Tons	Cu %	Ag oz.	Au oz.
Lyell-Comstock	13,595	2·18	0·2	0·028
North Mount Lyell	14,873	4·74	0·88	0·008
Total ore	30,468	3·43	0·54	0·018
Concentrates	8,622	10·95	1·47	0·047
Recovery		90·41	77·79	72·41

The ore is crushed to 2 in. and sent to rolls, where it is reduced so as to pass screens consisting of perforated steel plates, either 7/64 in. diameter hole by 0·194 in. centres by 16 gauge, or ⅛ in. diameter hole by 0·22 in. centres by 14 gauge. The ore then goes to tube-mills.

On account of the limited room available for the plant, gear-driven tube-mills were adopted. These are driven by 75 h.p. motors, and have flexible couplings on both rotor and counter shafts. For the purpose of standardizing motor speeds generally on the works, 750 r.p.m. motors were used, but this high pinion speed cannot be recommended. Fabroil pinions have a life of about five months, but better results are obtained with locally-made phosphor-bronze pinions, run in an oil bath, in which case phosphor-bronze bearings are used on the rotor shaft. The mills are run in both directions of rotation, thereby extending the life of pinions and inside liners. The mills are 16 ft. long by 5 ft. diameter, with a hollow trunnion bearing on the feed end, and a forged steel tyre 2 ft. 9$\frac{5}{16}$ in. diameter running on cast-steel rollers on the discharge end. The shell is built in three sections, bolted together by means of heavy angle irons. The liners, which are ribbed, are manufactured locally from hard cast-iron. The wear on the end liners, which are also ribbed, is more severe, and these are replaced individually as required. Owing to the irregularity in supply and quality, and also the high cost of flint pebbles, Tasmanian quartzite pebbles are now used. These average 2½ in. to 4 in. in size, and the consumption amounts to 11 lb. per ton of ore.

Two Dorr thickeners take the overflow from the diaphragm cone classifier, and are of the standard design for 20 ft. diameter tanks. The speed is ⅛ r.p.m., and the discharge averages 40% solids. The tanks are of steel construction, with $\frac{3}{16}$ in. plate shell and ¼ in. plate bottom. Gate valves on a 4 in. discharge pipe regulate the discharge. The feed is laundered into a wooden box, 2 ft. square by 1 ft. deep, with a central pipe 8 in. diameter, that extends 12 in. below the surface, covered by a screen to collect chips, etc. A diving ring, 30 in. diameter by 48 in. deep, of $\frac{1}{16}$ in. plate, concentrically surrounds this pipe, and prevents any surface eddies.

The tube-mill and thickener discharge join in the boot of the feed elevator, which delivers to a balance cone, 2 ft. 6 in. diameter by 3 ft. 6 in. deep, at the head of the flotation boxes. Pebble fragments that escape the discharge grating of the tube-mills are caught on a screen at the elevator boot. The main flotation unit is of the standard Minerals Separation type, and contains 12 agitation and spitz-boxes. The stirrers are four-bladed, 19 in. diameter, revolving at 320 r.p.m., the line shaft being driven by a 75 h.p. motor. Two-bladed paddles, revolving at 19 r.p.m., are provided for skimming off the float at the lip of the spitz-boxes. The addition of frothing media is made to the tube-mill feed, with such additions as may be necessary at the flotation boxes, generally only at starting up, until the thickener bow is normal and regular conditions are obtained. A mixture of one part of eucalyptus oil to two parts of coal tar is fed by a disc feeder to the diaphragm-cone discharge before being split between the two mills, and eucalyptus oil to each tube-mill through ¼ in. pet cocks from pipes connected to a supply tank. The tar consumption is 0·1 lb. and the eucalyptus oil 0·8 lb. per ton of ore. Compressed air is introduced immediately under No. 1 stirrer in limited quantity, and tends to produce a crisper float on the first boxes. The float from the last four spitz-boxes is returned as a middling to the feed elevator. The dilution of the flotation boxes is maintained at about 4½ to 1. On account of the difficulty in settlement of the slimed gangue of the Lyell-Comstock ore and its tendency to sicken the float and lower the grade of concentrates, the flotation section is arranged in open circuit, that is, there is no return tailing water. Sulphuric acid is not found to be necessary in the treatment, although indicated in the experimental investigation of North Mount Lyell ore. The improvement in grade of concentrates by the use of acid is offset by a drop in recoveries. The flotation solutions are not heated, but conditions improve with rise in temperature. The temperature of solution varies from 47° F in winter to 74° F in summer. A separate flotation unit, the subject of Australian Patent No. 2353 of 1916, by the author, was installed to retreat the concentrates from the Minerals Separation flotation boxes. It consists in forcing atomized air into the oiled pulp, in a launder-shaped box, by means of high-pressure water through an ejector.

The paper also describes the plant installed for filtering concentrates, the elevating system, methods of tailing disposal, and the power plant.

SHORT NOTICES.

Butte & Superior Mining Methods.—In the *Mining and Scientific Press* for October 9, A. B. Parsons describes the mining methods at the Butte & Superior zinc mine, Montana.

Gold Mining in British Guiana.—The *Engineering and Mining Journal* for September 25 contains an article on gold mining in British Guiana.

Ferro-Concrete in Mining.—*Engineering* for October 15 describes in considerable detail, with full working drawings, the ferro-concrete pit-head gear at Bentley Colliery, Doncaster.

Flotation of Oxidized Lead Ores.—In the *Engineering and Mining Journal* for October 16, Glenn L. Allen describes the methods employed by the Shattuck-Arizona Company for concentrating low-grade argentiferous lead-carbonate ores. The ore is ground fine, the coarser parts being treated on tables. The remainder and the tailing are treated with sodium sulphide solution which coats the carbonate particles with sulphide of lead, thus making them amenable to flotation treatment.

Flotation.—The August *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa contains a paper by H. R. Adam, giving a discussion of recent literature on the theory of flotation.

Flotation.—In the *Mining and Scientific Press* for October 2, James M. Hyde writes on the testing of ores for flotation.

Flotation.—*Chemical Engineering and Mining Review* (Melbourne) for August describes the Du Faur flotation machine.

Flotation.—In the *Mining and Scientific Press* for September 25, W. D. Green and W. Fagergren describe the concentration of tailing heaps consisting of rejects at the Midvale lead smelter, Utah. This material consists of lead, zinc, copper, and iron sulphides, and the treatment consists of the Bradford differential flotation process

Smelting at Spassky.—In the *Mining and Scientific Press* for September 18, H. C. Robson describes the smelting of copper ores with bituminous coal, as conducted at Spassky, Siberia.

Production of Tungsten.—*Chemical and Metallurgical Engineering* for October 6 publishes a translation of a paper by Camille Matignon in *Chimie et Industrie* describing French methods of producing tungsten powder and ferro-tungsten.

Analysis of Cobalt Alloys.—The *Journal of Industrial and Engineering Chemistry* for October contains a paper by J. R. Camp and J. W. Marden on the analysis of alloys consisting of cobalt, molybdenum, and chromium, such as shellite.

Analysis of Light Aluminium Alloys.—In the *Journal of Industrial and Engineering Chemistry* for October, R. M. Berry describes a rapid method for the analysis of light alloys containing 90% or more aluminium.

Talc in Paint.—In *Chemical and Metallurgical Engineering* for October 6, R. B. Ladoo shows that the "asbestine" used in the preparation of fire-resisting paint is not composed of asbestos but of fibrous talc.

Bolivian Tin-Silver Mines.—In the *Engineering and Mining Journal* for October 16, J. T. Singewald describes the tin-silver mines of the Colquechaca district, Bolivia, which have recently been reopened.

Carnotite in Colorado.—In the *Engineering and Mining Journal* for October 16, B. Burwell describes the mining of carnotite in Colorado, the uranium-vanadium mineral worked as a source of radium.

Tin in Japan.—The *Journal* of the Imperial University of Japan for May contains an article by Takeo Kato on copper-tin lodes in the Akenobe district, province of Tajima, Japan. The author states that the lodes containing copper, tin, and wolfram are found in fissures in Paleozoic slates and that they are associated with diorite rocks in the neighbourhood. Granitic rocks are reported to be absent.

Nigerian Geology.—The *Geological Magazine* for October contains an article by Gerard W. Williams on the geology of the Ningi Hills, Northern Nigeria, to which is added an appendix by R. H. Rastall giving a petrographical description of specimens.

Brazilian Diamonds.—In the *Geological Magazine* for October, R. R. Walls writes on the geology of the diamond districts of Brazil, mentioning the discovery of diamond pipes by David Draper.

Tungsten in Burma.—In *Economic Geology* for September, J. Morrow Campbell writes on the tungsten deposits of Burma and their origin.

Artificial Graphite.—The *Iron and Coal Trades Review* for October 8 describes the manufacture of artificial graphite as carried on at the works of the Newcastle Graphite Company.

Wire Ropes.—The *Iron and Coal Trades Review* for October 1 gives an illustrated description of the wire-rope works of the Whitecross Co., Ltd., at Warrington.

RECENT PATENTS PUBLISHED.

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 1s. to the Patent Office, Southampton Buildings, Chancery Lane, London, W C.2., with a note of the number and year of the patent.*

14,267 of 1914. R. D. LANCE, Paris. Extracting metals from ores by first forming chlorides in any known way, and then precipitating the metals as oxide by the action of soluble oxy-chlorides of alkaline earth metals.

13,020 of 1919 (151,052). J. C. BLAKE and W. MCNAUGHT, Girvan. Incandescent electric lamp for mounting on miner's cap.

13,945 of 1919 (151,318). INTERNATIONAL EARTH-BORING MACHINE CO., Chicago. A boring machine, intended particularly for excavating vertical holes, such as are required for foundations.

15,205 of 1919 (150,836). GENERAL ELECTRIC CO., Schenectady, New York. Improved apparatus for making nitric acid from the oxides of nitrogen.

15,406 of 1919 (151,339). F. J. PHILLIPS, London, and E. J. ROSE, Sherwood. Production of soluble silicates of potassium and sodium, of higher silica content than usual.

15,561 of 1919 (151,098). C. T. THORSSELL and H. L. R. LUNDEN, Gothenburg, Sweden. Improvements in the production of cyanides by allowing nitrogen to react upon a mixture of coal and alkali metals, or alkaline-earth metals, or their compounds in the presence of finely divided metals reduced from a metal compound added to the mixture in the form of a compound containing no ingredients other than the metal itself, hydrogen, oxygen, carbon, and nitrogen, characterized in that the metal is reduced from the mixture at a temperature lower than 550° C., for instance, during the pre-heating of the mass of reaction, and then immediately introduced as quickly as possible into the zone of reaction.

15,946 of 1919 (151,374). G. H. CLEGG, Cardiff. Method of recovering the valuable constituents of skimmings from tin-plate baths.

17,320 of 1919 (151,400). C. B. BACKER, Montreal. A light alloy composed essentially of 85 to 98% magnesium, 1·5 to 14% aluminium, and 0·75 to 6% of zinc.

17,779 of 1919 (150,875). A. C. WHITTOME, Johannesburg. Improved atomizer, particularly for laying dust in mines.

19,085 of 1919 (151,422). P. CHAILLAUX, Paris. Method of converting stibnite into the higher sulphides of antimony which are used as gold and vermilion pigments.

19,426 of 1919 (151,426). S. O. COWPER-COLES, London. Improvement in the drums used in sherardizing, that is, covering objects with zinc by heating in zinc dust

21,040 of 1919 (131,898). DEUTSCHE MOLYBDAEN WERKE, Halle, Germany Improvements in the inventors' process for extracting molybdenum from molybdate of lead (wulfenite) by treatment with solutions of alkali sulphides.

20,148 of 1919 (151,440). A. E. DAVIS, Birmingham. Pulverizers for comminuting coal and other substances.

24,129 of 1919 (133,319). C. F. BURGESS LABORATORIES and O. W. STOREY, Madison, Wisconsin. Method of producing zinc chloride by the action of chlorine on zinc in the presence of water or water vapour, the particular object being to remove the chloride from the zinc surface as soon as it is formed.

25,879 of 1919 (151,489). A. STEVENSON and A. LOGAN, Glasgow. Improved gear for coal-cutting machines.

26,740 of 1919 (150,917). G. BRUSA and V. BORELLI & CO., Turin. A machine for making mercuric oxide from mercurous nitrate and making more nitrate by reacting on mercury with the oxides of nitrogen released

29,378 of 1919 (135,847). P. M. T. SAVÈS, Toulouse, France. A compound fertilizer made by mixing cyanamide of lime with silicate of potash.

30,132 of 1919 (141,666). ROCHETTE FRERES, Chambery, France. Production of alkaline aluminates, free from acid oxides such as sulphurous acid, suitable for the production of pure alumina or salts of aluminium.

4,234 of 1920 (151,528). S. FISHER, Johannesburg. Cradle for holding hand hammer-drills.

12,189 of 1920 (151,567). G. H. T. RAYNER, Sheffield. Improvement in the inventor's valve mechanism for rock drills.

14,638 of 1920 (151,572). W. ESCHBACH, Cologne. In the manufacture of blasting detonators, the use of an aluminium shell with a loading of lead azide or mixtures of lead azide and similar initial detonating compositions inert toward the metal, which can be easily clipped on to the quick-match by the clamping-tongs.

NEW BOOKS, PAMPHLETS, Etc.

☞ Copies of the books, etc , mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London Wall, E.C.2.

Prospecting for Oil and Gas. By LOUIS S. PANYITY. Cloth, octavo, 250 pages, illustrated. Price 18s. net. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

In response to the insistent demand by the public of late years for information on the petroleum and natural gas industry, a number of short text-books have made their appearance in the United States and Great Britain, apart from numerous papers in technical journals and revised and enlarged editions of the standard text-books on the subject. As is to be expected, some of the newer books are immature and somewhat superficial, and bear evidence of hasty preparation, though they fulfil the purpose of their authors in introducing the subject to the layman. The general defect observable is that the experience of most of the authors has been confined to one country or one type of oilfield. The experience of English authors has been gathered chiefly on Tertiary or Cretaceous fields; that of American writers mainly on the great Eastern and Central Paleozoic fields of the United States; a few combining also an experience covering the Mesozoic and Tertiary fields of the United States, Canada, Mexico, and possibly the Northern republics of South America.

Thus Mr. Panyity's book under review is purely North American in its scope, its text being based almost exclusively on conditions obtaining on the Paleozoic fields of the United States. It treats in a cursory and often elementary manner the various problems and the field practice within these limits. Without considerable knowledge of geology, surveying, drilling, and oil and gas-production, the chapters and appended tables on those subjects are of little practical use to the reader. The book should, however, be useful to the layman or the young student as an introduction to the subject, and as a stimulus to further study of the problems involved. More careful editing would have eliminated a number of obvious errors.

When it is considered that the Tertiary oilfields of the world are of much greater importance than the fast-declining Paleozoic oilfields of North America, a handy text-book of pocket size, giving due weight to the special problems of what are now recognized as the major oilfields would be welcome.

The value of a text-book largely depends upon the scope and reliability of the literature available, and it is therefore to be hoped that those other countries which control important oilfields will imitate the excellent and public-spirited practice in respect of research and publication of information of the United States Geological Survey and Bureau of Mines. A great opportunity in this direction is now possible to the British Empire by the recent establishment in London of the Imperial Mineral Resources Bureau.

J. A. L. HENDERSON.

Manual for the Oil and Gas Industry under the Revenue Act of 1918. By RALPH ARNOLD, J. L. DARNELL, and others. Cloth, octavo, 200 pages. Price 13s. 6d. net. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

This volume was originally published as a bulletin of the Oil and Gas Section, Internal Revenue Bureau, U.S.A., and in its present form is designed to act as a guide to the making of Federal Tax returns by persons connected with the oil industry in the States. It is divided into three main sections, of which the first discusses the many legal aspects of the industry, the second, the case of depreciation of property and methods of assessment, and the third and largest, the methods of computation of underground oil reserves. This latter section, by reason of its universal importance and application, merits considerably more than the mere passing attention which is usually allowed to statistical publications of this nature.

The authors base their estimates of recoverable underground reserves of oil on the basis of graphical representations of decline in production of a chosen set of wells operating under similar conditions. For this purpose the average production per well per annum (in barrels) is plotted against the actual years in question, and in this way the "production decline curve" can be obtained. From this curve the probable future production of the well over a number of years is obtained by extending the curve in conformity with its general symmetry. That such an extension possesses more than a mere theoretical value is attested by the fact that the symmetry or regularity of the curve is obtained in the first place over a number of years in which the production is accurately known, and so far from being a chance factor, is one which is entirely obedient to the natural laws controlling the flow of the oil. The method obviously necessitates that records over at least four years are available, and as the authors themselves state, the estimation is not entirely satisfactory until several years' production has been attained. Where the wells are much younger than this, the "appraisal-curve" method can be adopted, in which case the ultimate production per well (in barrels) is plotted against the production per well in the first year. The validity of this method is based on the following generalization, which we give verbatim: "If two wells under similar conditions produce equal amounts during any given year the amounts they will produce thereafter, on the average, will be approximately equal, regardless of their relative ages." Such a conclusion of course can only apply to wells fed from the same oil-pool, and even then may be open to criticism, notwithstanding the fact that many thousands of well-records were examined in different localities before the authors inclined to this opinion. The authors apply these methods successfully to most of the important fields in America and in Mexico, and thus throw a flood of light on the whole question of the United States oil supply of the future, a vital matter not only to that country but to others who, like ourselves, are mainly dependent on her for their sources of petroleum.

H. B. MILNER.

Waddington Old Hall. Album published for private distribution by JOHN WADDINGTON, J.P., D.L.

It is not often that men known in mining circles tell us the intimate details of their homes. A notable exception occurred a few years ago, when Sir Boverton Redwood's house in Avenue Road, Regent's Park, formed the subject of a paper read before the Royal Society of Arts. His house is entirely modern in construction, and it is a wonderfully good copy of an ancient manor house. In this connection it forms a pleasing contrast to Dr. Ludwig Mond's more bulky Victorian mansion a few doors higher up the road. Now comes Mr. John Waddington with an illustrated description of his Yorkshire home. Mr. Waddington's house dates from a remote antiquity, but after he had rescued it from the partial neglect and oblivion on the part of previous owners, it assumed a remarkable likeness to Sir Boverton's. Waddington Old Hall is in Yorkshire, near the Lancashire boundary, not far from the towns of Clitheroe, Whalley, and Chatburn, and within sight of the River Ribble, and of Pendle Hill, the highest ground in South Lancashire. The district is of interest to mining engineers, as it is limestone country and has yielded much galena. The neighbourhood is full of romantic associations, centering largely around Whalley Abbey. The Jesuit college at Stonyhurst diffuses through the district a subtle emanation of profound learning, while Harrison Ainsworth has told of the old-time superstitions prevalent in this part of the country in his "Lancashire Witches." But not the least interesting of all the bygone events took place at Waddington Old Hall, for here it was that Henry VI. lay concealed from his enemies after a defeat at one of the battles in the Wars of the Roses. The Anglo-Saxon Chronicle records that Earl Wada lived here in 798. In the Domesday Book the village appears as Wadeton, and in Edward I.'s time mention is made of Roger de Waddington. During the last two centuries, the Old Hall lost its political importance, and its historical glamour was not appreciated by its owners. However, its former glories have been to some extent restored by Mr. John Waddington, who has liberally applied some of his wealth derived from the Great Boulder mine in removing the undesirable accretions and exposing the old stonework to the light of day once more. The secret passages and staircases are once again available, King Henry's bedstead is on show, and the house has been refurnished and decorated in a style as near the original as is compatible with modern ideas of comfort. The album containing a historical description and an excellent series of photographic views forms a suitable memento of the Hall and its long history. There are many houses of this type scattered over England which deserve similar treatment at the hands of descendants who have a pride of ancestry. To mention one only, Yaverland Manor House, in the Isle of Wight, now a dairy farm, is waiting rescue by someone having Mr. Waddington's spirit. These old houses are not only full of historical and family interest, but they also have the advantage of being cosy and restful. All those who have the antiquarian instinct will thank Mr. Waddington for restoring the Old Hall and for preserving the records in the album to which we here make reference.

Mine Book-Keeping. By ROBERT McGARRAUGH. Cloth, octavo, 120 pages. Price 12s. net. New York and London: McGraw-Hill Book Company.

COMPANY REPORTS

Consolidated Main Reef. — This company was formed in 1896 as a consolidation of two companies operating on the outcrop in the middle west Rand. Main Reef East and Main Reef Deep were absorbed in 1909, and Main Reef West in 1918. More recently part of the adjoining Bantjes has been acquired on a royalty basis. The control was with Neumann's, but was transferred to the Central Mining-Rand Mines group after the death of Sir S. Neumann. The report for the year ended June 30 last shows that 639,241 tons of ore was raised, coming chiefly from the Main Reef Leader, and that, after the removal of 12½% waste, 558,241 tons averaging 7·7 dwt. per ton was sent to the mill. The yield by amalgamation was 147,438 oz., and by cyanide 56,027 oz., making a total of 203,465 oz. The par value of this gold would have been £864,000, but owing to the premium the sum received was £1,039,396, or 37s. 3d. per ton. The working cost was £812,361, or 29s. 2d. per ton, leaving a working profit of £227,035, or 8s. 1d. per ton. Out of the profit, £155,950 was paid as dividend, being at the rate of 12½%. During the past year the amount of development work done was much greater than usual owing to the necessity of increasing the reserves. For some time the results were discouraging, but later on high grade ore was discovered in the lower levels between Nos. 3 and 4 auxiliary inclines, and the position here is now more hopeful. The development in the Bantjes area has been unsatisfactory, and has been stopped. The reserve in the Leader is estimated at 1,179,100 tons averaging 7·6 dwt. per ton, and there is also 6,900 tons averaging 8·1 dwt. in the South Reef. There will be no difficulty in raising ore of the same grade during the current year as was mined during the two previous years, but the profit will depend primarily on the price of gold.

Nourse Mines.—This company was formed in 1894 as the Nourse Deep, and operates a property in the central Rand. The control is with the Central Mining-Rand Mines group. Mining is rendered difficult by an unusual number of dykes and faults. The report for the year ended June 30 last shows that, owing to a slight improvement in native labour supply, the tonnage milled was rather greater than during the previous year. On the other hand the costs went up by 2s. 10d. per ton, and if it had not been for the premium on gold the year's work would have resulted in a loss. The ore raised was 525,635 tons, of which 53% came from the Main Reef Leader, 41% from the South Reef, and 6% from the Main Reef. After the removal of 9% waste, 477,300 tons, averaging 6·7 dwt. per ton, was sent to the mill. The yield by amalgamation was 100,758 oz., and by cyanide 53,326 oz., making a total of 154,084 oz. The par value of this gold would be £654,000, but owing to the premium the receipts were £789,609, or 33s. 1d. per ton. The working cost was £701,639, or 29s. 5d. per ton, leaving a working profit of £87,970, or 3s. 8d. per ton. Bringing the balance from the previous year into the account, the available balance at the end of the year was £241,189, out of which £62,086 was distributed as dividend, being at the rate of 7½%, £6,533 was disbursed as taxes, and £38,532 was spent on capital account, the remainder being carried forward. The development disclosed 556,000 tons averaging 7·6 dwt., and the ore reserve was well maintained, the figures being: Leader 770,740 tons averaging 7·1 dwt., South Reef 723,210 tons averaging 6·9 dwt., and Main Reef 56,300 tons averaging 5·6 dwt. The best results came from the South Reef. An increased number of stoping drills have been introduced so as to counteract the effect of underground labour shortage. The scale of development of the South Nourse section is to be increased now that the headgear has been re-erected and the new winding engine has been installed.

Willoughby's Consolidated. — This company was formed in 1894 to consolidate various land and mining enterprises controlled by the late Sir John Willoughby. The control is now with the British South Africa Company. The report for 1919 shows that, at the Eiffel Blue gold mine, 14,386 tons of ore was raised and treated, for a yield of gold worth £23,480. At the end of the year it became clear that work was no longer profitable, so the mine was closed. The Eileen Alannah mine, which had been closed since June, 1918, was reopened toward the end of 1919, and up to December 31, 9,137 tons of ore was treated. At the Connemara mine tributers raised 46,495 tons, which yielded gold worth £50,056. The Birthday asbestos mine, in which the company has a 40% interest, is opening up well and is now on a profit-earning basis. During the year 1,271 tons of fibre was sold, and during the first eight months of 1920 the sales have been 1,812 tons. The mining interests of the company are comparatively small, land and cattle providing the chief business. The accounts for the year show an adverse balance of £24,915.

Transvaal & Rhodesian Estates.—This company conducts a land business in various parts of South Africa and has interests in mines. It works the Fred gold mine in the Filabusi district of Rhodesia. The report for the year 1919 shows that, at this mine, 21,200 tons of ore was treated for a yield of bullion realizing £69,064. The working profit was £25,006. The ore reserve at December 31 last was estimated at 52,000 tons averaging 14 dwt. per ton. Developments on the 9th and 10th levels were bad, and in May of this year G. A. Denny was asked to report, stoping being suspended in the meantime. Mr. Denny advised certain development work, which has given encouraging results. In particular a cross-cut from the 6th level has disclosed a parallel lode of considerable promise. The accounts of the company show a balance of profit of £23,771, which is carried forward.

Abbontiakoon Mines.—This company was formed in 1901 as the Abbontiakoon (Wassaw) Mines to acquire gold-mining property in the Tarkwa district, West Africa. Edmund Davis is chairman, and for many years Stanley H. Ford was superintending engineer. Mr Ford has joined the board recently. The report for 1919 shows that 91,186 tons of ore was treated, yielding gold worth £210,630, of which £21,144 represented premium. The working costs were £187,182, interest on loans £802, and income tax £3,680. The balance of profit was £18,963, which was carried forward. The ore reserve at December 31 last was estimated at 391,629 tons, averaging 10·16 dwt., and there is also 564,000 tons of ore below 7 dwt. per ton. These figures show a slight increase in tonnage and decrease in assay-value as compared with those of the year before. The lode has not yet been found on the 16th level, owing presumably to faulting. Diamond-drilling is now being done in order to find the continuation of the ore-body in depth.

Swaziland Tin.—This company was formed in 1905 under Transvaal laws to work alluvial tin properties near Embabane, in Swaziland. Particulars of the work done here were given in the MAGAZINE for March, 1917, by J. Jervis Garrard. The report for the year ended June 30 last shows that 957,906 cu. yd. was treated for a yield of 297 tons of concentrate, being an extraction of 0·695 lb. per yard, equal to 0·49 lb. metallic tin per yard. The income from the sale of concentrate was £57,120, and the net profit £18,199, out of which £14,350 has been paid as dividend, being at the rate of 17½%. The proved gravels are estimated at 1,914,177 cu. yd., averaging 0·59 lb. of metallic tin per yard. A large area of the lower flats remains to be tested. With regard to mining practice, it is notable that gravel pumps are being superseded by hydraulic elevators.

Lower Bisichi (Nigeria) Tin Mines.—This company belongs to the Tin Areas of Nigeria group, and was formed in 1912 to work alluvial tin property on the Lower Bisichi river, Bauchi province, Northern Nigeria. The report for the year ended September 30, 1919, shows that 87 tons of tin concentrate was won, and that the profit was £3,795. Out of this, a dividend at the rate of 10% and a bonus of 2½% have been paid, absorbing altogether £2,552. The engineer is of opinion that the rate of output will be increased in the near future. In September, 1919, the company purchased the Rudos area from the Tin Areas Co. for £16,000, paid in shares of the company. The output of the company for the year ended September 30, 1920, was 83 tons.

New Lafon Tin Fields.—This company was formed in 1914 as a reconstruction of the Central Lafon Tinfields of Nigeria. In August, 1919, the properties were sold to the newly-formed Associated Nigerian Tin Mines, Ltd., for 388,000 5s. shares. The report for the year ended September 30 shows a profit of £4,583, derived from sales of tin concentrate, realization of investments, dividends, etc. Out of this, £3,214 is being distributed as dividend, being at the rate of 12½%. The directors are considering the acquirement of new properties. The option which the Rayfield company had on the unissued capital of the New Lafon has been cancelled.

Renong Tin Dredging.—This company was formed in 1908 to work alluvial tin deposits on the Renong and Pakchan rivers in the Western Siamese States. E. T. McCarthy is a director and F. W. & R. Payne are the consulting engineers. The report for the year ended June 30 shows that Nos. 1, 2, and 3 dredges treated 1,508,983 cu. yd for an output of 578 tons of tin concentrate, being a yield of 0·86 lb. per yard. No. 2 dredge has been transferred to the company's new ground at Rasa, in Selangor, Federated Malay States. No. 3 dredge was working difficult ground, full of boulders, for many months. The sale of concentrate brought an income of £125,266, and the net profit was £22,935. Bringing in the balance from the previous year, £24,254, there was an available balance of £47,189. Out of this, the shareholders have received £21,640, being at the rate of 15% on the 25,000 preference shares and 15% on the 175,000 ordinary shares. The sum of £10,000 has been placed to reserve. Particulars of the Rasa company were given in our issue for February last. It is expected that No. 2 dredge will commence work there before the end of 1920.

Porco Tin Mines.—This company was formed by Avelino Aramayo & Co. in 1912 to work a tin mine in Bolivia. The report for the year 1919 shows that 21,280 tons of ore was treated, for a yield of 278½ tons of tin concentrate. The result of working was a loss of £1,507, in addition to which £6,456 was due as interest on debentures and loans. The manager, A. B. Reece, reports that the reserve stood on December 31 at 10,550 tons averaging 1·6% metallic tin. This reserve has since been mined and treated and the mill is now running chiefly on custom ores. Great difficulty has been experienced in marketing the tin concentrates.

North Anantapur Gold Mines.—This company was formed in 1908 by John Taylor & Sons to acquire property at Anantapur, Madras Presidency, India. Milling commenced in 1910 and payment of dividends in 1913. The scale of operations and profits has never been large, and developments have been poor during the last three years. The report for the year ended June 30 shows that the revenue has been derived mainly from a rich pocket in the 650 ft. level. The ore milled was 9,000 tons, yielding 13,418 oz., and 9,900 tons of tailing was treated by cyanide for 700 oz. of gold. The total gold, 14,118 oz., realized £62,592, of which about £2,592 came from premium. The working cost was £24,196, out of which £10,000 has been placed to reserve, £4,240 written off for depreciation, and £12,586 paid as dividends, being 5s. 6d. on each £1 preference share and 1s 6d. on each £1 ordinary share. Development work has been greatly restricted owing to poor encouragement, and work is mostly confined to stoping known reserves. On June 30 these reserves were estimated at over 10,000 tons. In view of the early exhaustion of the mine, the directors have been seeking other outlets for the company's capital, and are examining copper mines in Chota Nagpur.

Associated Gold Mines of Western Australia.—This company was formed in 1894 to acquire a number of gold-mining leases at Kalgoorlie. Some of these were sold to other companies, and the Australia leases were worked, for many years profitably. Of late years the scale of operations has been restricted, and no dividend has been paid since 1914. The report for the year ended March 31 last shows that 54,484 tons of ore was treated for a yield of gold realizing £92,775, of which £14,243 represented premium. This amount of premium was not the total receivable, but was that due from the sale of about ⅝ths of the gold delivered during the first nine months of the year under review. The net profit was £9,704, but as the year started with an adverse balance of £18,568, the position at the end of the year was a debit balance of £8,864. The reserve of broken ore in the stopes at the end of the year was estimated at 45,187 tons averaging 25s. per ton at the par value of gold, as compared with 27,482 tons averaging 23s. 9d. the year before. Development has continued to disclose ore. If it had not been for scarcity of labour, more ore could have been treated and a greater amount of development done.

Broken Hill Proprietary.—The report of this company for the year ended May 31 last is devoted chiefly to the iron and steel industry, as the lead-silver-zinc mines at Broken Hill were closed during the whole period owing to the strike. At Newcastle, the operations were seriously curtailed by two strikes of seamen and marine engineers, and by continual shortage of steamers for bringing iron ore when there were no strikes. Consequently the furnaces were out of blast on several occasions. The output of the two blast-furnaces was 169,409 tons of pig iron, and the output of the foundry furnace was 1,730 tons of pig iron, 12 tons of spiegeleisen, and 1,271 tons of ferro-manganese. Of the total, 39,677 tons was sold, and the remainder used in the company's steel plant and foundry. The open-hearth steel furnaces produced 166,772 tons of steel ingots. Owing to the scarcity of scrap, it is intended to install furnaces of the "duplex" type, which do not use scrap. The blooming mill produced 151,681 tons of blooms and billets. The 28 in., 18 in., 12 in., and 8 in. rolling mills produced rails, beams, angle-irons, etc. The rod mill is to be duplicated. The company's net profit from all sources was £517,662, of which £500,000 has been transferred to reserve fund. Particulars relating to the intended expansion of the iron and steel works were given in the MAGAZINE for October.

The Mining Magazine

W. F. WHITE, *Managing Director.* EDWARD WALKER, M.Sc., F.G.S., *Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LIMITED AND REDUCED, AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938.* Telegraphic Address: *Oligoclase.* Codes: *McNeill,* both Editions.

BRANCH OFFICES: 420, Market Street, San Francisco. 300, Fisher Bdg., Chicago. 2,222, Equitable Building, New York.

SUBSCRIPTION 16s. per annum (Single Copy 1s. 6d.) including postage to any part of the World.

Vol. XXIII. No. 6. LONDON, DECEMBER, 1920. PRICE 1s. 6d.

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EDITORIAL

IN spite of the fog, the conversazione of the Institution of Mining and Metallurgy, held on December 9 at the Royal School of Mines, was a huge success. We take this opportunity of thanking the President and Council for a pleasant social evening, in which scientific instruction, concerts, dancing, cinema shows, and an excellent supper were happily blended. It was appropriate that the conversazione should be held at South Kensington, rather than at reception rooms in the West End, as formerly.

THE gold medal of the Institution of Mining and Metallurgy has been awarded to Sir Thomas Kirke Rose in recognition of his services in the advancement of metallurgical science, with special reference to the metallurgy of gold, and the Consolidated Gold Fields medal and premium have been awarded to Mr. H. Livingstone Sulman for his paper read before the Institution, entitled "A Contribution to the Study of Flotation." The latter award may, in a sense, be taken as a confirmation of the Institution's high opinion of Mr. Sulman and his work, and as token that their confidence in him has not been shaken by the outburst of adverse criticism which arose in certain quarters in America when the paper in question was read and the gold medal presented to him last year. In connection with the awards now announced, it is of interest to note that Sir Thomas Rose was in a previous year awarded the Gold Fields medal, and that he and Mr. Sulman are the only members who have been recipients of both medals.

UNIVERSITIES have been hard hit by the increased cost of living and of supplies, especially as these conditions have arisen at a time when the roll of students has increased enormously. Our Melbourne correspondent gives an idea of the position in Australia in this connection. McGill University, at Montreal, has had a whirlwind campaign for funds, and has raised over $6,000,000 dollars in a week, among the subscribers being the Government of Quebec, the Canadian Pacific Railway, and the Rockefeller Foundation. In this country, Birmingham and Leeds Universities are the latest to make public appeals, each of them asking for £500,000. Birmingham has already received responses from many of the oil magnates, who have between them contributed nearly £200,000. This recognition of Sir John Cadman's fine work as professor of mining and oil technology is particularly gratifying. It is to be noted also that Rangoon is to have a University, and that the Government of India is taking an active share in its inauguration.

BRUNNER, Mond & Co. believe in a University education, as contrasted with a purely technical training, when looking for likely members of their staff. In the course of a recent lawsuit, in which a shareholder protested against the company's funds being used in subscribing to University endowments, their representative said that they required men of broad education, capable of dealing with the growing range of problems continually arising, rather than men specializing on laboratory routine. Judging by the results obtained by the firm, this policy is evidently sound.

DISSATISFACTION has been expressed recently in various quarters with regard to the policy of the Department of Scientific and Industrial Research, the grievance being that the results of the researches are not available to the general public. The cudgels have been taken up against the Department by the National Union of Scientific Workers, and, in particular, Professor Soddy, Dr. J. W. Evans, and Mr. H. G. Wells have made public utterances on the subject. They say that the results are not given to the Universities or other teaching and research institutions, and that they are only available for the business firms who contributed funds and took part in the campaign. Not only do the Universities not obtain the results, but the manufacturers and engineers who did not join in the work of the Department are also ruled out. It is argued that, as the Department is supported by public money, the reports of new developments obtained under its control should be made public property. The Department has not replied officially to these attacks, but statements have been circulated, presumably by someone in authority, to the effect that it is inadvisable to give rival nations the results of research, and that it is natural that, both from this point of view and also because of the financial and other support given, the information obtained should be the private property of the firms associated with the research. These statements also contain the wholly unjustified taunt to the effect that Universities never did anything for indus try. Our own experience with the Department is the same as that of the National Union of Scientific Workers. The Tin and Tungsten Research Committee has certainly issued reports on some of the results obtained, but these are all of scientific interest only, and find no immediate practical application. On the other hand, we know of research work that has yielded results of direct practical value, but these results are not available for publication. At one time it was generally believed that the Department was created for the good of the general public. It now appears evident that it is intended as a subsidized trade research organization. It is just as well to know how matters stand, though the pity is that the position was not known earlier.

DR. Morrow Campbell's paper on the Origin of Primary Ore Deposits, read at the October meeting of the Institution of Mining and Metallurgy, raised so much interest that the discussion was continued at the November meeting. We were glad of this continuation of the discussion, because it afforded Professor H. C. H. Carpenter the opportunity of making some remarks as to how this class of paper strikes a metallographist. The general effect of his speech was to impress on the geologist the fact that he, the geologist, is in very deep waters when speculating upon possible reactions in solution and crystallization. Professor Carpenter gave the meeting an outline of the principle of thermal equilibrium, and demonstrated the modern scientific basis on which these studies should be followed. His most cogent remarks were to the effect that it was impossible to tell, from the structure of an alloy, whether it had been deposited from a liquid or a solid system, without knowing what had happened on cooling from the liquid to the ordinary temperature, and that, moreover, there might be other changes taking place; for instance, there might be reactions between solid phases, forming an entirely new combination and accordingly a new type of crystallization. Geologists, and the Institution generally, are to be congratulated on having received this direction toward a new aspect of the study of ore deposits, coming from so high an authority. Undoubtedly those interested in this branch of geological theory will now be well advised to take more than a casual dip into metallography.

Another contributor to the discussion at the adjourned meeting was Mr. S. J. Speak, who emphasized the disinclination of many engineers to deduce the history of a lode from its present appearance. He quoted the great divergence of evidence and arguments based upon it brought forward by Dr. W. R. Jones and Dr. Morrow Campbell with regard to the paragenesis of wolfram and cassiterite. As these two geologists differed so widely it could only be supposed that the evidence produced by both was not truly characteristic, and that the deductions were based on mistaken lines of argument. Another speaker at the meeting, Mr. A. B. Edge, referred to the formation of large masses of pyritic material such as are found in the south of Spain, and gave his theory of their deposition from water solutions as contrasted with the silicic acid solutions of Dr. Morrow Campbell. For ourselves we doubt whether water need be considered in these cases at all, for their mode of origin seems to be fully explained by Mr. W. H. Goodchild's hypothesis.

While writing of the discussion on Dr. Morrow Campbell's theory, we may draw attention to a paper quoted at considerable length in the Mining Digest, which contains a suggested explanation of the existence of complex silver minerals in association with cassiterite in Bolivia. This paper is an excellent presentation of the complexity of Bolivian ores and of a theory which seeks to harmonize the occurrence with the present orthodox views of the origin of ore deposits.

What is a Bank?

The word "Bank" is as difficult to define as "Ore," and it is just as liable to be wrongly applied by interested parties. Some years ago there was reason to protest against the use of the word in connection with companies formed to finance mining issues and mining speculations; at the present time the City is again much annoyed at the existence of certain companies called So and So Banks, which are not banks at all, but private financial institutions. We revert to this question as to what is a bank because the president of the Institute of Bankers, Mr. Walter Leaf, has drawn attention to the matter in his annual address. One of the difficulties of fixing an exact definition is that gradual changes arise in connection with the lending, deposit, and collection of moneys; certainly a definition suitable now would not fit the conditions of a century ago. Another difficulty lies in the fact that though the taking of deposits from the public, repayable on demand, constitutes the predominant feature in arriving at a definition, yet that is not the actual portion of the business requiring the brains and providing the profit, which is the lending of these funds to advantage. In looking for a definition, attention may be turned first to the Oxford Dictionary, which says that a bank is an "establishment for the custody of money, which it pays out on the customer's order." That contains the whole essence of the idea from the point of the public, but it is not sufficient for the requirements of financial circles. Turning to the law for a definition, it is found that such a definition is entirely lacking. No Act has ever said what is the meaning of the word "bank," nor is there any decision of a Court of Law on the point. The nearest that can be found is contained in the Bills of Exchange Act, which says that a "banker" includes a body of persons, whether incorporated or not, who carry on the business of "banking," a jewel of perspicuity that might be expected in a legal document. A recent attempt on the part of the law to define a bank was in connection with remission of taxation on interest on the public loans subscribed during the war. The Finance Act of 1915 spoke of relief of taxation for "any bank carrying on a bona fide banking business in the United Kingdom." As Mr. Leaf says, this is not a definition, but more like a helpless appeal for one. Apparently the Inland Revenue Authorities will have the power to decide whether each bank does a bona fide banking business or not. Another reason why an exact definition of the word has been wanted by the Government during the last few years has been in connection with the foreign banks, particularly German banks, which have or had agencies in this country. In a report made for this purpose to the Government by a committee of which the late Lord Cunliffe was head, the word was defined thus: "A bank, as the term is understood in this country, may be broadly described as a firm or institution whose main business is to receive from the public moneys on current account repayable on demand by cheque." This definition is open to the objection to which reference has already been made, that is to say, that the "main business" is not the same as the "main source of revenue." Mr. Leaf himself adopts a definition on these lines, but without reference to a main business. Lord Cunliffe's committee also included as banks all institutions bearing the word in their title. At first sight this inclusion seems paradoxical, and so it is if the definition is considered without its application. It really means that no company is to be called a bank unless it conforms to the usual regulations as regards publicity. Finally we come to Mr. Leaf's own suggestion that a Register of Banks should be established, without any hard and fast definition of the word, and that a tribunal should be set up, representative of the Government, of banking, and of industry and commerce, having the power to consider each case separately. Seeing that it has proved impossible to evolve a satisfactory inclusive definition, this suggestion seems to be a useful alternative. Thus we may leave the matter for the present, trusting that Mr. Leaf's views will receive due consideration. In concluding this short note, it is necessary to say that the discussion relates to British banking alone, for Continental and even American practice does not follow the same rules.

The Slump in Metals.

The recent slump in the metal markets was sufficient to alarm the most confirmed optimist, and many are the conjectures as to the cause. The hard and unpalatable truth about the fall in metal prices is that too many people have been speculating on the bull tack, who, unable to carry on any longer, or being disturbed by the general financial and industrial outlook, have been forced to throw their holdings overboard at last almost regardless of prices. There was never any warrant for the extremely high levels to which prices were driven during the war and since. Powerful interests, however, were actively engaged in holding up supplies, and in pushing things their way. Their open encouragements and predictions of higher prices brought in speculators who, as usual, got left at the top, together with some of their advisers. The losses incurred have been colossal, and assistance has had to be given in a number of cases, the latest being that of a firm with world-wide ramifications, and until a few weeks ago credited with the possession of unlimited resources.

No range of commodities could present a more graphic chart of the ramp that had been going on than metals. The preposterous prices fixed for copper under the joint Allied control naturally brought into operation scores of mines whose combined quota resulted in the world being grossly over-stocked when the war ended. Then the big American producers sent over a Commission to Europe to look into the position, the members of which beguiled themselves into thinking that during 1919 they were going to sell Germany alone some 200,000 tons of copper. All arguments tending to cool down this misguided enthusiasm were brushed aside, and the producers went on merrily piling up stocks, which are now unsaleable. Probably at some price they will begin to effect a clearance, but in the meantime they seem to be merely floundering, and it is sheer guess-work even to attempt to fix the level at which they can liquidate. Moreover, by their extraordinary business policy they have succeeded in alienating the sympathy of the very people who could have helped them, that is, the London dealers. American copper producers indeed not only want the cake but the paper in which it is wrapped. A free market with dealers would have been an enormous boon to them, for it would have maintained a steady flow of trade at slowly dwindling prices, during which period of gradual readjustment production could have been reduced to meet the new situation arising. Instead of this we have had a crisis in prices, and still have a deadlock in sales. The high and mighty air of the big American copper interests has been indeed quite out of place.

The unlimited optimism encouraged in tin some months ago brought in a rag, tag, and bob-tail of gamblers, whose default and repudiation of contracts when the inevitable smash came caused the liquidation of one big firm, and the ensuing legal proceedings are likely to provide a full cup of interest for some time to come. In its later stages, the price of tin was undoubtedly manipulated upward in order to make a high market to sell on, and the smash came when bear manipulation commenced, based upon the big stocks of Dutch tin in Batavia, and upon movements in the guilder exchange. The fall was dramatic and sensational, but the manipulating group, when the depression from the extreme figures was about £150 per ton, turned round and a stronger market was seen, a new bull account being created. The unfortunate financial and industrial position, especially in America, and the general deflation in progress in commodity prices, however, soon made an end of much of this, and prices again reacted heavily.

Lead has been the subject of probably the most untiring efforts by big people to put up prices and to keep them high. These people talked as if even £45 to £50 per ton were a moderate figure for lead, emphasizing the impending world scarcity, and harping without ceasing upon the Broken Hill strike, a strike by the way most fortunately protracted, as it happened, for the bulls. Here again was gambling on a colossal scale, in which Dick, Tom, and Harry all did their bit, and are mostly poorer men to-day in consequence. Finance of course was the ultimate factor in breaking down the movement, by forcing the liquidation of metal held off the market. The people who had the lead, and were holding it up, ultimately found the game too costly. They did not want the metal themselves, while consumers, unable to sell their products because prices were prohibitive, would not shoulder the burden. Even the device of shipping thousands of tons of lead back to America was futile. The device may have been a smart one, but it broke the American market, and did not materially assist the position here. France grossly over-estimated her capacity of absorption, and has for weeks past been a re-seller of imported lead which she can neither pay for nor use.

Spelter has also suffered, though not so severely as other metals, but here we have had the Government, by keeping a tight hand over the concentrates which it holds, playing the same old game of bolstering up prices. There is, however, no great excess of output at the present time, and although the price is hardly likely to slump much, the tendency will no doubt be downward in the long run.

The position of things to-day arises partly, of course, from the political policy of the Allies, for which France is mainly responsible, of preventing the development of trade with the big Central European markets and Russia. This policy has worked havoc with the foreign exchanges, and with the progressive restoration of the world's finance and its industry. Not until Germany, Austria, and Russia are opened to trade without restriction, and exchanges can be stabilized, can the world's consumption of metal be expected to take care of a reasonable output. This, however, is so self-evident a truth that no politician can be expected to recognize it.

The Beringer Memorial.

The Camborne Mining School is issuing an appeal for subscriptions to a memorial to the late Mr. J. J. Beringer. Every mining man and metallurgist in this country, and indeed in all English-speaking countries, should feel responsive to this call, for have not each one of us received some benefit from his work and teaching in one way or another? The old students at Camborne naturally derived the greater benefit owing to their personal contact with him, though the debt due from those who have used his book on assaying is not much less. But his instruction in metallurgy and assaying was only one phase of his public usefulness, for he was also a great champion for a rational system of scientific education. Unfortunately he met many rebuffs while endeavouring to put metalliferous mining education on a proper footing in Cornwall and in England generally, partly owing to Cornish inertia and partly owing to the indifference of Government educational authorities. Nevertheless, his doctrines and propaganda have left a permanent impression in scientific and technical circles, and if he never received full credit, it is at any rate well to know that his principles are now generally accepted by the leading teachers.

It is hardly credible nowadays that mining education in Cornwall, when he first took charge, was not based on any systematic plan, in spite of the early efforts of men like Mr. Benedict Kitto, Mr. Richard Pearce, and the late Mr. J. H. Collins and Sir Clement Le Neve Foster. There were schools at Camborne, Redruth, and Penzance, and classes at various other places, but they were all poorly equipped with teaching staffs and the necessary apparatus. Beringer immediately took in hand the concentration of this low-grade material, and by his advice Camborne School was made the centre of activity. The method of imparting instruction when he took control was based to a large extent on the rule of thumb. In fact the instruction, even when under the control of the distinguished men before-mentioned, was chiefly intended for working miners. Assaying was taught to men who knew nothing of the principles of chemistry, and mechanical drawing to students ignorant of elementary geometry. He changed all that, particularly at Camborne, and in a minor degree at Redruth, and he established systematic courses of studies founded on the logical sequence of subjects. Gradually the regular courses became predominant, and, whereas in 1900 only 30% of the students were taking the regular course, by 1906 fully 90% were thus enrolled, and only a small proportion were taking haphazard or special lines of study. As a natural corollary to the establishment of this regular course, he instituted the Diploma for successful students, but unfortunately he was never able to secure Government recognition for it, so that "officially" a Camborne man still remains an unqualified mining engineer. The School is not alone in suffering from this coldness of the Government, for the Royal School of Mines men are equally disqualified from taking responsible positions in foreign countries, owing to their diploma not carrying the necessary Government backing.

Another of Beringer's strenuous campaigns was undertaken in association with Le Neve Foster for the reorganization of the Royal School of Mines and the inclusion of Camborne School in a general scheme of mining training for the country. These proposals, however, were not popular in certain quarters, and unfortunately these personal difficulties still stand in the way of a scheme which would add greatly to the efficiency of both schools. On the failure of this national plan, attention was then centred on the amalgamation of the Camborne, Redruth, and Penzance schools, under the control of the Board of Education. When the Government terms were settled, it was found, to the consternation and disgust of Beringer's friends, that he was ruled out of his position as principal by a clause which provided that the holder of this post should be a mining man. In spite of this rebuff he remained loyal to the school, and thereafter devoted his energies to the metallurgical and assaying department.

Beringer was the victim not only of Government neglect, but also of the inertia and narrow-mindedness of the majority of men of local influence, who desired to limit the facilities of the Cornish schools to students of Cornish parentage or residence. He and his small band of supporters met with much opposition when announcing their ambition to make Camborne a teaching centre of national or even international repute. The bulk of the rich men of Cornwall strongly objected to providing funds for extensions and endowments for the benefit of "foreigners." This attitude reacted on the School when Government assistance was sought, for the Board of Education naturally looked askance at a school which failed in finding extensive local support.

The foregoing is an outline of Beringer's activities in the cause of education. With Camborne School always in financial straits, and with little countenance from Government Departments, it is clear that he never received the pecuniary reward due to a man of his calibre and single-mindedness. Thus it is appropriate that the founders of the Memorial should decide to pay his widow the interest on the funds raised, and to defer the application of the moneys to the establishment of scholarships and prizes. Contributions on a large scale are not asked; anything from one to twenty-five pounds will be welcome. There must be hosts of his old pupils, and of mining men and metallurgists who have used the "Treatise on Assaying" to advantage, ready in a practical way to make acknowledgment of benefits received. These should communicate with Mr. T. Knowles, at the Mining School, Camborne, the Honorary Secretary of the Fund.

REVIEW OF MINING

Introduction.—A severe drop in the price of metals, including silver, has been the feature of the month. As regards trade in general, conditions are gradually becoming worse. Issues of new capital are difficult to negotiate, as there is little response from the public. The question of taxation is assuming an acute form, and it is generally felt that new schemes for expenditure must be prevented.

Transvaal.—The market for South African gold shares is much disturbed at present owing to the impending sale of enemy shares held by the Public Trustee in this country and by the Custodian of Enemy Property in South Africa. The South African Government has already invited tenders, but whether this action is taken in concert with the Public Trustee here is not certain. Shares of this description are difficult to sell at present, particularly in France, and attempts to interest America in Rand shares appear to have failed. What success the two Governments will have remains to be seen, but it is probable that they will have to hold the bulk of the property for some time yet.

The Government of the Union of South Africa has appointed a Commission to inquire into various questions concerning the coal trade of the country, as set forth: (1) The measures required for (a) the effective grading and pooling of South African coal intended for export or for bunkering; (b) the equitable distribution of the cost of such grading and pooling among the participating collieries; and (c) the discouragement of the export of low-grade coal; together with a draft Bill or regulations for giving effect thereto. (2) (a) The necessity of safeguarding the supply of coal for local consumption and for the use of the South African railways and harbours and other public services; and (b) the measures required to ensure such a supply. Sir Robert Kotze is chairman, and other members represent the mines and railways. The position is anomalous, for in Natal high prices have lately been the rule, while in the Transvaal the prices have not been raised greatly. The contracts between the mines and the railways require some sort of revision, and the relations between the two parties to the contracts should be placed on a more equitable footing.

The New Heriot company is going into liquidation, and the assets are to be realized as soon as possible. The mine will be abandoned about the end of the month, after all the saleable plant has been raised.

The Van Ryn, during the year ended June 30, yielded 417,635 tons of ore, of which 408,430 tons went to the mills. The total yield of gold was 98,197 oz., or 4·81 dwt. per ton, selling for £503,248, or 22s. 3d. per ton. Against this was working cost £398,425 or 19s. 6d. per ton. Shareholders received £75,000, being at the rate of 15%. The reserve of ore payable at the par value of gold is 1,147,170 tons averaging 5·6 dwt., but with gold at 115s. a further 439,800 tons averaging 3·6 dwt. could be brought into the estimates. It is not likely that any more ore will be developed, but there are large amounts that can be drawn from pillars, etc., reclamation work for which is in hand.

The Middleburg Steam Coal & Coke Co. announces the creation of debentures for the purpose of supplying capital for additional plant and the necessary development to increase the rate of output. The company has also obtained mining rights over a further 800 acres.

Diamonds.—The demand for diamonds in this country and America is slackening, and a reduction in the rate of dividends may be expected in the near future. The Premier mine is operating at reduced time, only two shifts instead of three being worked. The report of the De Beers company for the year ended June 30, which is published this month, does not reflect this fall in demand to any great extent, though the increase in revenue was not as great as had been expected.

The Frank Smith Diamond Company resumed washing operations on November 8, after having been shut down on the outbreak of the war. The company was reorganized at the beginning of 1920, under conditions recorded at the time. The control is with Barnatos and Ehrlichs.

Cape Province.—The Cape Copper Co. has issued £120,000 8% debentures for the double purpose of providing additional funds for the completion of the metallurgical plant at the Rakha Hills copper mine, India, and of prospecting in the neighbourhood of the old mines in Namaqualand, Cape Province. With regard to the latter work, a geological investigation has been made by Mr. H. M. Kingsbury.

Rhodesia.—The Jumbo Gold Mining Co. reports that the Tip Top mine is being reopened. During its two years' closure, there have been many falls of rock, and a good deal of retimbering has to be done.

The Surprise Gold Mining Company, one of the Willoughby group, was never a great success as a gold producer or promoter of gold-mining companies. Just recently the Birthday asbestos property, in which it has an interest, has developed into a profit-earner, so in order that shareholders may receive dividends from the profits accruing, the capital of the company is to be written down from £1 to 4s. For the eight months to August 31, the sale of asbestos fibre was 1,812 tons, and the output is gradually increasing to a regular 300 tons.

West Africa.—Labour and fuel shortage and increased costs have combined to reduce the output and profits at the Ashanti Goldfields. For the year ended June 30, the amount of ore treated was 71,411 tons, and the yield of gold 76,522 oz., decreases of 14,155 tons and 21,196 oz. as compared with the previous year. The revenue from the sale of gold was £410,226, of which £81,349 was premium. The profit for the year was £122,332, and £145,229 was paid as dividend, being at the rate of 62½%, some part of the dividend coming from the balance brought forward. A change in metallurgical practice is to be inaugurated in order to reduce the labour employed and the amount of wood consumed in roasting. Instead of dry-crushing, roasting, and cyaniding, it is intended to crush in stamps and concentrate, the concentrates only to be treated by roasting and cyaniding. The total extraction of gold will be slightly less, but the cost will be much reduced.

Nigeria.—The scarcity of labour and the low price of tin have combined to cause many groups operating in Nigeria to consider ways and means of effecting economies and strengthening their position both locally and in the London market. Last month we mentioned that it was proposed to amalgamate the Keffi, Jemaa Exploration, and Toro as the Keffi Consolidated. This scheme has since received the assent of shareholders in the individual companies. This month we record similar steps being taken to amalgamate the Jantar, Kuru, and Kuru South. Another scheme involves the amalgamation of the Bisichi Tin, the Forum River, the Ninghi, and the Northern Nigeria Trust. A fourth proposal, of which there is some talk, though no official proposal has been circulated, relates to the Tinfields of Northern Nigeria and the Naraguta Extended. The weakness of this scheme is that the Berrida, Champion Tin, Lucky Chance, and Rukuba are to be brought into the amalgamation. As these other companies are of a somewhat shaky nature, they are hardly suitable for amalgamating with two companies which are doing quite well.

The Kaduna Syndicate and Kaduna Prospectors are issuing joint notes to the extent of £30,000, bearing 10% interest and convertible into shares of either company within five years. The additional capital is required for the purpose of prospecting over 26 square miles and 32 square miles respectively, the regulations on which the prospecting licences are held requiring that considerable work should be done in this connection. These two companies have a steady output of concentrate and their capitalization is low.

Australia.—The gold mines at Kalgoorlie have been the victims of another strike of woodcutters and were obliged to close for a time. The Broken Hill strike is at an end, as recorded last month. Mining operations have been resumed, and word comes to hand that a start has been made at some of the mills.

The Mount Lyell company treated, during the year ended September 30, 107,864 tons of Mount Lyell ore, 50,992 tons of North Lyell ore, and 10,740 tons of concentrates. The yield was 4,580 tons of blister copper, containing 4,536 tons of fine copper, 168,109 oz. silver, and 5,164 oz. gold. Under present conditions of labour and difficulties of realizing products the dividend usual in December has not been declared.

The Kalgurli Gold Mines company reports that the reserve is rapidly coming to an end. Fourteen of the twenty levels are exhausted, and only the 100 ft., 1,250 ft., 1,350 ft., 1,450 ft., and 1,650 ft. levels are yielding ore. The total reserve on July 31 was 20,000 tons averaging 7 dwt., together with 8,200 tons broken in the stopes, averaging 6 to 7 dwt. During the year ended July 31, 35,179 tons of ore was raised and sent to the mill. In addition 25,624 tons of custom ore was treated. The yield of gold per ton from the company's ore was 38s. 3d., par value. The profit for the year was £30,270, out of which £24,000 has been distributed as dividend, being at the rate of 20%. The policy of the company in keeping the mill going by custom work has greatly helped in lowering the costs and so earning a profit.

Malaya.—Malayan Tin Dredging, Ltd., reports a diminished output for the year ended June 30 last, owing to a number of stoppages for repairs and overhaul of the dredges. The delivery of the two new dredges ordered some time ago has been delayed chiefly by labour troubles, but shipments are expected to begin before the end of 1920.

Southern Perak Dredging, Ltd., was formed rather over a year ago by the Malayan Tin

Dredging group for the purpose of treating alluvial tin ground at Temoh, in the district of Batang Padang, Perak. The construction of the dredge, designed by Messrs. F. W. & R. Payne, is now in hand, and it should be delivered at the property about the middle of 1921. The hull is 162 ft. long and 48 ft. wide; the buckets are close-connected and have a capacity of 9 cu. ft.; the dredging depth will be 55 ft. below water; the capacity will be 120,000 cu. yd. per month. The boilers are designed so as to be suitable for either coal or oil.

Developments at the chief mine of the Pahang Corporation have given excellent results during the past year, rich tin ore having been found in depth. Owing to the irregularity of the lodes and the great extent of workings, it is not possible to give exact calculations as to the reserve, but the amount is estimated at 700,000 tons. During the year ended July 31 last, 178,200 tons was sent to the mill, where 2,199 tons of tin concentrate was extracted. In addition, 160 tons of alluvial tin was won, making the total production 2,359 tons. The profit was £152,279, out of which £26,000 was written off for depreciation, £30,000 placed to taxation reserve, and £20,000 allocated to the account for new pumping plant. The preference shareholders received £15,000, being at the rate of 15%, and the ordinary shareholders £75,000, being at the rate of 20% for the year.

Cornwall.— Paragraphs in the financial papers advertise a new issue of shares by the Treburgett Consolidated Mines. Adverse criticism was made of this venture in our issue of January last. Our only comment at present is that it is no use trying to get support for a mine containing so much zinc.

British Zinc and Lead.—The production of zinc ores in this country has nearly ceased, and the only yield comes as a small by-product from lead mines. Thus Halkyn in Wales has been producing some, as have also Thornthwaite and Threlkeld, but the last two are now closing down for a time, as the price of lead as well as the price of zinc is at present too low for profit-earning. These mines are, however, being kept in good order and some development is being done. The Force Crag zinc mine in Cumberland has suspended operations, as has also the East Halkyn in Wales. At Alston the only mine working is the Nentsbury. The Greenside lead mine in Cumberland has been closed after attempting in vain to obtain some rebate on the present harsh royalty terms, and the company is now in liquidation. The Weardale Lead Co. paid a handsome dividend for the year ended September 30, but it is hard hit by the slump in lead that has taken place since. As regards zinc smelting in this country, it is practically non-existent. The only plant running is that of the Sulphide Corporation at Seaton Carew. This, however, is working on quite a small scale.

Minerals Separation.—The speech of the Chairman at the meeting of shareholders of Minerals Separation is an annual event to which mining engineers and metallurgists look forward. At the meeting last month stress was laid on the new venture in connection with coal refuse and "colloidal" fuel. Some time ago the company became interested in a process for separating fine coal from refuse. This process makes it possible to reclaim mountains of waste coal, which is too fine to treat in the ordinary washers, and British and foreign colliery owners have not been slow to appreciate the importance of the scheme. Among those interested may be mentioned the Powell-Duffryn company, in South Wales, the Skinningrove Iron Co. in North Yorkshire, and the Chinese Engineering and Mining Company. The fine coal separated by this method from stony matter is suitable for the manufacture of briquettes, and for coke-making. The other application to which reference is made above involves the mixture of the coal dust with oil-fuel, and the production of a so-called colloidal fuel, which is suitable for use wherever ordinary fuel-oil is employed. Reference has already been made in these columns to this colloidal fuel, and to the work done in this connection by Mr. Lindon W. Bates. The process has been taken up by Minerals Separation, and it is being examined scientifically and practically with a view to ascertaining the characteristics and behaviour of the fuel. It cannot be said that the fuel has won its spurs yet, and indeed it has come in for a considerable amount of adverse criticism, particularly at recent meetings of the Institution of Petroleum Technologists. There seems to be some doubt whether the coal-dust is permanently held in suspension in its entirety; if the coal has a tendency to settle, there will be considerable difficulty in using the fuel, and from a scientific point of view it cannot in such case be called a colloidal fuel. Then again the question has arisen whether the fine coal and oil will not react on one another, and the hydrocarbon portion of the coal go to making volatile oils. These are two points on which more light is required, and no doubt the technical staff of Minerals Separation will be able to clear up some of these doubtful features and produce an acceptable market product.

Canada.—The Keeley Silver Mines, Ltd., reports that the mill, having a capacity of 60 tons per day, was started on October 19, and ran continuously until November 21, when the electric current supplied by the local power company failed. From February 3 to date, $61\frac{1}{2}$ tons of ore and concentrate was shipped to the smelters.

United States.—The report of the Tomboy company, operating in Colorado, shows a loss for the year ended June 30 last, owing to the cost of changing over to the flotation process and the interruption of output. The amount of ore treated was 146,066 tons. The bullion produced in the mill was worth $107,919 and by cyanide $28,646, while the various concentrates were valued at $672,735. As the change of treatment was made during the year, these figures do not reflect the actual treatment. The accounts show a debit balance of £42,891. It has not been possible to obtain a saleable zinc concentrate, so this part of the new scheme has been abandoned for the present. As regards development, high-grade ore is still being found in the Virginius vein, which, however, is narrow. A typical assay is $21·32 in gold and silver, 5·3% lead, 7·9% zinc, and 0·5% copper, over 1·13 ft. The system of shrinkage stoping recently introduced at the Montana mine has proved a failure owing to so much barren rock being brought down with the ore.

Mexico.—The Mexico Mines of El Oro is issuing 29,942 new £1 shares as the purchase price of 93,500 shares in the Compania Exploradora de Minas de Mexico. The latter company was formed in 1915 for the purpose of testing and developing new properties, and of the total capital of 200,000 shares of 10 pesos each it acquired 106,500. It is with the object of obtaining the entire shareholding that the present issue is made. At the same time 60,058 new £1 shares are to be offered to present shareholders at £5. 10s. each, in order to complete the purchase of the new properties and to provide equipment. No particulars as to these new properties have as yet been issued.

In our October issue it was mentioned that the Santa Gertrudis was intending to invite subscriptions to new capital. The prospectus of this issue was advertised last month, when notes to the extent of £300,000, bearing 8% interest, were offered. The reason for this issue is the increased cost of equipping and developing the new properties, and it is also desired to replace the funds subscribed on the flotation of the Mexican Corporation.

The Buena Tierra Mining Co., one of the Exploration Company group, operating a silver-lead mine in Chihuahua, is offering notes to the extent of £66,000 for subscription among shareholders. These notes will carry 10% cumulative interest and will have a currency of five years. The new capital is required for financing an increased scale of development recommended by Mr. Basil Prescott, a geologist who has recently made an investigation.

The San Francisco Mines of Mexico has got rid of its old contract for the supply of its zinc concentrates to the Hydraulic Power & Smelting Company, of Norway, by the payment of £5,600, and the company is now free to deal with its material to the best advantage according to circumstances. The pilot zinc concentrator plant was started on July 26, and plans are now being drawn up for the construction of a commercial plant.

Colombia.—The British Platinum & Gold Corporation announces that No. 1 dredge has started work. The constructional parts of No. 2 dredge are in course of shipment; some have already arrived in Colombia, and the remainder will leave Liverpool this month.

The South American Gold & Platinum Co. is controlled in the United States, but the Consolidated Gold Fields of South Africa has a large shareholding. The property is near that of the British Platinum property mentioned in the previous paragraph. The first dredge of the South American company recovered 6,349 oz. of platinum and 972 oz. of gold during 1919, and the returns for 1920 so far received show a substantial increase. No. 2 dredge commenced work in August. A third dredge is now being built and should start work about the middle of next year.

Peru.—A year or so ago the Darymusu company, formed to operate in West Africa and Nigeria, turned its attention to a gold-dredging property in Peru. Shortly afterward the Kalgurli Gold Mines, Ltd., took an option on the property and sent out engineers to make an examination. This month a cable has been received reporting unfavourably, and the option has been dropped.

Bolivia.—The British Government has withdrawn its veto against the transference of Aramayo Francke Mines, Ltd., to a Swiss company to be formed for this purpose, and meetings of shareholders are accordingly to be held authorizing the winding up of the English company. The object of this transference is to avoid the payment of British income tax on the part of the Bolivian shareholders who have a preponderating holding in the company.

THE MINES AND MINERALS OF YUNNAN
SOUTH CHINA.

By J. COGGIN BROWN, O.B.E., D.Sc.. M.Inst.M.M., F.G.S.

Geological Survey of India.

(Concluded from November issue, page 277).

The author gives a description of the mineral resources of Yunnan, the most south-westerly of the Chinese Provinces, adjoining Burma and Tongking.

FUTURE OF COPPER MINING IN YUNNAN.—In my previous article I gave particulars of the known copper deposits of Yunnan, and showed that the output is lower nowadays than it used to be. This decline of copper mining during the last 50 or 60 years is due to a number of causes. Prominent among the internal ones are the following:

(*a*) Partial exhaustion of rich ores above ground-water level.

(*b*) Political disturbances and strangulation by too strict official control.

(*c*) Destruction of the forests with no attempts at reafforestation, and consequent lack of charcoal in large quantities at the smelting centres at cheap prices.

(*d*) Difficulties of transportation.

Although I believe that the earlier French writers were to some extent led astray by too complaisant an attitude toward Chinese accounts, and formed too exaggerated an opinion of the copper resources of Yunnan, I do not accept in their entirety the rather gloomy predictions of the engineers who have investigated the question at later dates. It is admitted that there are no important deposits within reasonable distance of the Tongking-Yunnan Fu railway, but it is necessary to look further ahead when other lines will doubtless traverse the country, and open up regions which are now most inaccessible. I do not believe that there are any important deposits unknown to the Chinese, unless they are situated in the remoter parts of Yunnanese Tibet, neither do I think that the lean deposits of small extent will ever lend themselves to exploitation on modern lines. At the same time I am convinced that Yunnan possesses considerable reserves of copper ores, at depths at which indigenous methods have failed to reach them. While it is impossible to point to any particular example, I conclude that the larger deposits in the districts of Tung-ch'uan Fu, Wei-ning Chou, Yung-pei T'ing, and perhaps Lin-an Fu, Li-chiang Fu, and Wei-hsi T'ing, merit careful individual attention, and that some of them will probably repay the attention which they may receive. The future growth of copper mining and smelting in Yunnan will depend on scientific application of the most recent practice, and this cannot be done either by European or Chinese until better transport facilities are created in most cases, and a more generous attitude is adopted by the Administration towards all.

LEAD AND SILVER. — Although it seems probable that in the past Yunnan has furnished large quantities of silver from the cupellation of argentiferous lead, to meet the demand in other parts of China, the available information regarding the deposits themselves is meagre. The Chinese exploitation of the Bawdwin mines in the Northern Shan States of Upper Burma for silver proves how far afield the old Imperial Government was once prepared to extend its operations in search of silver. Some idea of the importance of lead and silver mining in Yunnan about the middle of the 18th century can be gleaned from the long list of mines given by Rocher. Leclère in 1898 estimated the annual production of lead in Yunnan at 3,000 tonnes. He did not think that the deposits were important enough to justify expenditure on communications to them. Lodes containing lead ores were not as numerous as copper lodes, and he considered that they are only well developed in certain localities, notably around Ko-chiu and Wei-ning Chou. In the former locality the lode at Long-teo-tchai was extensive and very regular, though when Deprat wrote in 1911 the workings had been abandoned. It was clear that many of the residues accumulated under the Chinese system would be amenable to European treatment. Lantenois received information regarding an argentiferous lead mine at Pan-san, one stage to the north of the Ouai-teou-chai mines, where there were estimated to be 10,000 tonnes of lead slags probably worth re-treatment. Duclos remarks on the difficulty of separating lead and zinc mines owing to the constant association of galena and zinc blende in Yunnan. He has given a long list of mines compiled from Chinese sources. Davies has drawn attention to the fact that there is an export trade in lead and zinc as well as copper from Yunnan to the Yang-tze valley. Regarding the occurrence of silver he wrote: "The metal is if anything more abundant than copper, and one can seldom travel far in Yunnan without seeing or hearing of silver mines. I doubt if there is any large district in the province which does not produce silver. Many of the mines are well worked and Yunnan supplies much of the silver used in other parts of China."

LEAD MINING IN THE MING-KUAN.—This is the name given to part of the valley of the No-lo Ho, a tributary of the Lung-chiang, which is the Shwe-li of Upper Burma. It lies about 30 miles due north of Têng-yüeh, and some 24 miles due east from the Burma frontier in the vicinity of Myitkyina. That the valley has been the centre of a considerable copper and lead-smelting industry in the past is proved by the number of old adits that enter the hills at various places, by the remains of ancient furnaces, and by the slag heaps. I found slag heaps at various places, the largest being at Hsiao-hsin-kai, Hong-too-hai, Kan-tung-pa, and in the valley which forms the pass leading from the latter place to Kai-tou. There is some reason to suppose that these slags could be re-treated profitably and the large quantities which exist make the Ming-kuan worthy of attention. I was told that some of the heaps were 300 years old. I examined ore deposits at Hsing-ai-chang, Tong-shan, and Hong-too-hai. At the former, prospecting operations in granite had revealed several promising-looking stringers of oxidized lead ores. At the second, the ore, consisting mainly of galena with some zinc blende, limonite, and oxidized copper ore, occurred as infillings in certain parts of a broken and re-cemented limestone. Hong-too-hai is the name given to a mountain over 6,800 ft. high. There are numerous portals of old tunnels and the remains of broken-down furnaces at its foot. Two levels were being worked, and the ore-body was met with about 120 ft. in from the portal. It was 15 ft. in width at the face, without its limits on either side being visible. A second level, some distance above the first, met the ore-body about 30 ft. in from the portal. Its limits were not visible. On the top of the mountain, over 200 ft. above the level of the lower adit, there is a large outcrop of, presumably, the same ore-body. Adjoining the limestone on its western side, it continued about 20 or 30 yards in breadth to the steep side of the mountain, where it could be seen cropping out some way down. In a north and south direction I traced the outcrop for over 120 yards. The ore consists of iron pyrites with small quantities of pyrrhotite, and smaller amounts of chalcopyrite and galena. There is a large quantity of it available, and I should like to have made a proper examination of the whole occurrence. This I was unable to do. The Chinese miners planned their workings to obtain the largest amount of lead and copper ores. There are several other localities in the Ming-kuan where argentiferous lead ores occur, and I consider that this valley, and the surrounding territory, is a field which holds out much promise to the prospector. Samples of galena from Tong-shan contained over 156 oz. of silver, and from Hong-too-hai over 123 oz. of silver and appreciable traces of gold per ton of lead. A slag from Hsiao-hsin-kai contained over 6% of metal, mainly copper, with a little lead.

The mining of galena by the Yunnanese is carried on under much the same rules as those adopted for other minerals. The ores are first hand-picked and then crushed by stamps or by hand. After concentration in sluice-boxes they are calcined with charcoal in stalls, and the agglomerated sintered material so produced goes to the blast-furnace. The lead-smelting furnace is from 7 to 9 ft. high, built of brickwork and lined with a refractory material. The shaft is roughly square in section with rounded corners, swelling out into a funnel shape toward the top, from which charging is done. The front is made of a double wall of brickwork which can be pulled out and renewed when necessary. It contains the slag and tapping holes. The cylindrical blower, generally worked by the vertical-axled water wheel, is raised a little above the level of the hearth, so that the tuyere slopes directly down into it. The lead is cast into small pigs and is then sent to the cupellation furnace. This is of hemispherical shape, between 5 and 6 ft. across. The hearth is only slightly concave and has a slope toward the door. There are two doors in the front, the lower one for charging and the upper one for firing. The metal is placed under the fire, which is supported on a grating above it, and is thus heated by radiation from the incandescent charcoal which forms the fuel. Litharge is removed by means of an iron rod. The process is a very tedious one, and the silver has to pass through the hands of a refiner after it comes from the cupellation furnace.

OTHER LEAD LOCALITIES.—Galena was mined on a small scale in the hills at the eastern extremity of the Pu-piao valley, Yung-ch'ang Fu prefecture, from a narrow vein in Permo-Carboniferous limestone. In Chêng-kung Hsien I was shown specimens of ores which were said to come from Yang-wan-shan, a locality in the hills to the south-west of the city. In Ching-tung T'ing I saw galena reported to come from the Chang-sa region. The two following mines are said to produce silver in the Yung-pei T'ing district: Pei-nin-ch'ang and Erh-p'ing-ch'ang. The mine of Lo-mi-cha, in the Li-chiang Fu prefecture, is said to produce silver. In a side valley at the head of the Mong-lai plain, passed by the road descending from Pang-wa in the Yun Chou district, there is an old lead mine. In the Chinese Shan States of Keng-ma and Mêng-hsa, on the Kun-lon ferry route to Yun Chou, it is said that there are three large lead mines which were abandoned about 100 years ago. Great quantities of slag are said to exist near them, and specimens were shown to me by the Shans. In appearance these slags were indistinguishable from those of Bawdwin. The two mines in Keng-ma are called Man-pien-ch'ang and Herh shan-ch'ang. The one in Mêng-hsa is said to be only six li from the town of that name.

ZINC.—Zinc blende is an almost invariable associate of galena in Yunnan. The chief use of the metal is as an alloy in the coinage of cash. I have not seen zinc smelting carried on, and as far as I am aware the ores are not reduced in the western or central parts of the province. They are said to be mined and smelted to the north of Hui-li Chou in Ssu-ch'uan, but the most important centre is at Wei-ning Chou, just within the borders of Kuei-chou. Duclos has described the methods adopted.

LEAD BLAST-FURNACES IN THE MING-KUAN.

FUTURE OF LEAD, SILVER, AND ZINC MINING.—The fall in the price of silver is held by some authorities to have been the chief reason for the decline of the lead and silver industry in Yunnan. If this be read with the causes I have already advanced in the case of the copper mines, such as the general economic paralysis brought about by the rebellion, the rigorous official control, the exhaustion of easily won surface ores, and the want of an abundant fuel supply, a greater measure of truth is probably arrived at. That modern methods can be successfully applied to ancient Chinese lead mines is proved by the operations of the Burma Corporation, and by the not inconsiderable quantities of mixed lead and zinc sulphides exported before the war from Hunan. The mixed sulphide deposits of the Ming-kuan and the reported occurrences in Keng-ma and Mêng-hsa, are within comparatively short distances of the Burma frontier. Their existence should not be lost sight of in this connection. Whether the deposits of the far interior will ever be worked on a large scale seems to depend more on the future development of communications in the province than on anything else.

TIN.—I have not visited the famous cassiterite deposits of Ko-chiu in the Mêng-tzu region of Southern Yunnan, but they have been described by Leclère, Deprat, and W. F. Collins. These mines and their associated smelters form the most successful mineral enterprise of Yunnan at the present time. According to Leclère the mineral is derived from the denudation of the upper portions of ancient lodes, owing their origin to the tourmaline pegmatites injected through strata up to the Lower Trias in age. When Mr. Collins visited the mines about 30,000 men were employed altogether, and the deposits then being worked were all of alluvial origin. (See his paper on the subject, December, 1909, Institution of Mining and Metallurgy, and THE MINING MAGAZINE for January, 1910.) Deprat believes it is unlikely that other tin-stone deposits will be found in Eastern Yunnan outside the Red River region, as the geological conditions are not favourable. I hold similar views regarding those parts of Western and Central Yunnan that I have traversed.

ORPIMENT.—The importation of orpiment (arsenic trisulphide) from Yunnan into Burma has been going on for a considerable number of years. The mineral is mentioned by the earlier writers who visited Upper Burma before the annexation, and of later years the traffic in the ore has increased, and the traveller by the main trade route is impressed by the number of mule caravans met with bringing orpiment down to Bhamo, whence it reaches Mandalay and Rangoon. Owing to the inaccessibility of the country and to the secrecy of the merchants engaged in the trade, no one had discovered the exact locality of the mines nor had they been visited by a European previously. They lie at the head of a narrow ravine, probably a tributary of the Yang-pi Ho, itself an affluent of the Mekong, at an elevation of over 8,000 ft. above sea-level, two days to the south-west of Hsia-kuan or three days from Ta-li Fu. Except for small isolated communities of Lolo tribes, the country passed through is uninhabited, and consists of bleak, sparsely-wooded mountains. Food for both man and beast has to be carried with the traveller. The district is unsurveyed, and my own observations were hampered by the inclemency of the weather. Blinding snowstorms swept the hills during my stay, and this, with the intense cold, made outdoor work somewhat difficult. The rocks in the immediate vicinity of the mines consist of reddish, reddish-purple, and hard greyish quartzitic sandstones, with black bands in places, and reddish nodular shales. Probably these rocks are associated with the Red Beds series. During the period of Mohammedan influence in Yunnan the mines are said to have been worked by the rebel powers centred in Ta-li Fu. After the fall of that city they have been entirely controlled by the Chinese. Mineral was being won from seven drifts which entered the hill on the north-east side and proceeded down as steep inclines, until the ore-bearing stratum was reached. The workings that I was permitted to examine had been made with thoroughness and care. None of the drifts were very extensive. The deposit appeared to be confined to one particular band of greyish quartzite, associated in places with soft black shales. The whole of the former band was more or less mineralized. There was no distinct vein or single fracture. A thorough shattering of the rock seemed to have taken place and orpiment to have been deposited in the bedding, joint, and fracture planes, and also to have replaced the minerals of the rock to some extent. Small quantities of realgar (arsenic sulphide) occurred, and minute cubes of iron pyrites were found. The arsenic sulphides were in irregular strings, swelling out into patches and bands, which sometimes attained a thickness of over 12 inches. These larger lumps, however, did not persist very far, but only continued a short distance before being replaced by others. The mineralized band was at least 4 ft. thick, perhaps much more, and I can express no opinion as to its lateral continuations, which may be considerable. I have no views to offer as to the origin of the ores. All the work was done by hammer and chisel, and the broken ore was carried to the surface in baskets. The richer pieces were picked out and the remainder roughly crushed and panned in closely woven bamboo baskets to separate the gangue. There was a great waste of the finer disseminated ore by these methods; indeed it was surprising how much material was rejected. The waste heaps must contain large quantities of mineral, which could be easily recovered by means of a simple concentrating plant. Most of the orpiment is exported to Burma, though a little, with the realgar, is kept for local sale.

GOLD.—Gold dust has always been an export from Yunnan, and quills of it may be purchased to-day about the frontier towns of Burma. There is a gold-beating industry in Ta-li Fu, and Yunnanese gold leaf doubtless gilded many of the old Burmese pagodas. Yet these facts, coupled with Marco Polo's story of the gold currency of the western dominions of the great Khan, and the custom of its inhabitants in covering their teeth with thin plates of gold, "which are fitted with great nicety to the shape of the teeth and remain on them continually," do not warrant the exaggerated notions of some writers regarding the auriferous riches of Yunnan. As far as I could gather there is only one lode-gold mine in the province, and most of the production, whatever its total amount may be, comes from a multitude of small placer workings operated spasmodically by the poorer inhabitants of the land along the banks of the greater rivers. The early Chinese writers mention four mines in operation about 1850, all of which seem to have been alluvial workings. Joubert, in 1867, stated that all the rivers of Yunnan carry gold, a statement which must not be taken too literally. His account of Ta-lang T'ing gold mines appears to be the only one ever published. At the base of and on the flanks of a mountain toward the north of the city, a very folded and fractured reddish sandstone is found overlain by slightly crystalline and compact limestone, traversed by serpentine dykes, crossed by numerous narrow quartz veins. These have been opened up by very numerous shallow workings over a distance of four kilometres. Both gold and silver are irregularly dispersed in the serpentine in the form of fine lamellæ and grains; they are found in a regular manner only in the interstices of the quartz veins or other rocks which traverse or border the serpentine. After crushing to powder, the ores are concentrated in pans and rockers, and the residue is treated with mercury to separate the gold contents. Leclère seems to have been much impressed with the gold-bearing deposits of Yunnan, especially with the

WORKINGS IN A HIGH-LEVEL GOLD-BEARING BENCH DEPOSIT NEAR A-LU-SHIH.

gravel benches and conglomerates of the Yunnanese course of the Yang-tze, which is known as the Kin-cha-chiang or "River of Golden Sands." According to Deprat, gold mines are numerous in the zone of the north and south folds of Ssu-ch'uanese Tibet, and the tributaries of the Yang-tze, such as the Ya-lung, coming from this region, carry gold into the parent river where it is found in the recent terraces or in the actual bed.

It is beyond question that the sands of the present river beds and of the raised terraces in the upper courses of the Salween, Mekong, and Yang-tze carry gold. Every traveller who has been in those parts of Yunnan has commented on the fact. Among others, Dr. Logan Jack, Major Davies, and the Swedish missionary Amundsen may be mentioned. Both the latter believe that the Mi-li country is rich in gold. This region is situated in and about the junction of the Li-tang with the Ya-lung. The State seems to be entirely Tibetan, and Mi-li itself, which is only about 20 miles beyond the Yunnan border, near the second bend of the Yang-tze, is described as practically nothing but a big monastery. The amateur opinions of Amundsen and Davies have been confirmed by specialists like Mr. H. W. L. Way, who wrote in THE MINING MAGAZINE in July, 1916, as follows: "From the Chien Chang valley through which flows the An Ning river on the east, to the Tibetan frontier on the west, and from Ta-chien-lu on the north to the Kin-sha (Yang-tze) on the south, there is a stretch of country that is without doubt richer in mineral wealth than any other part of China, and one of the most highly mineralized spots in the whole world. This is a region of great disturbance geologically, and it is full of lodes and veins carrying gold and metallic ores. The streams and rivers contain many deposits of alluvial gold. Evidences of mining activity are seen on all sides, and mule trains are seen carrying copper matte and metal, lead bullion, iron, and other metals. The lodes are worked in a primitive way in the oxidized zones by the aboriginal tribes under the supervision of Chinamen. The sulphides are left behind as too refractory." Mr. Way then describes the Maha gold mine and gives a long list of known mineral occurrences. It is only 40 or 50 miles as the crow flies from Maha to Ku-lu, where Davies was treated with suspicion, as the lamas thought that he had come to dig for gold. It is a much shorter distance to the borders of "Huang La-ma Tifang," as the Chinese call Mi-li. There are strong reasons for thinking that the geological structure is much the same across the whole region, and the fact that the western part of it is inhabited by a more or less independent race, unfriendly to the Chinese, may well have prevented its mineral resources from becoming better known.

Native placer workings are carried on all along the Yunnan course of the Yang-tze. I have seen them myself around Chin-chiang-kai, and from Ma-chang to the junction of the Ya-lung with the Yang-tze. At the former place, which is three stages to the north-east of Ta-li Fu, the gravels in the present river bed were being washed by tribes-people in the employment of the local Chinese. Further down stream the auriferous ground was won from shallow drifts into the high-level alluvium. Around Hsin-kai, the river terraces are pierced in many places by these old excavations.

Near A-lu-shih, a small town 20 miles north of Shunning Fu, gold washing was being actively carried on in a raised terrace deposit of a small tributary of the Yang-pi Ho, itself an affluent of the Mekong. The gold obtained was coarse and did not appear to have travelled far. It was probably derived from veins traversing the old slates of the vicinity. The deposit was not a large one, but interesting as showing another type distinct from the bigger ones in the rivers of northern Yunnan.

FUTURE OF GOLD MINING.—Regarding the future possibilities of alluvial or lode-gold mining in Yunnan or about its borders, all that can be said is that deposits exist which deserve careful testing. The Yang-tze, Mekong, Salween, Shwe-li, and their tributaries all carry gold. In this way they do not differ from the Irrawaddy and its branches, which may be regarded as members of the same group of rivers, as far as their upper reaches go. The Irrawaddy is the only one of the group in which long and careful tests have been made. Three gold dredges worked for years on this river above Myitkyina, and in 1918 ceased operations, which apparently could not be carried on profitably. Whether the alluvial deposits of the other rivers are richer or not is unknown. The Chinese are the most frugal race in the world and too many earlier writers have been led to dream of El Dorados, because they have seen a group of men eking out a miserable existence on lean gold deposits which no one else would touch. However, richer deposits may occur, but they will have to be sought for and investigated.

The most promising region for the occurrence of lode gold appears to me to be in the basins of the Ya-lung and its tributary the Li-tang in Ssu-ch'uan.

LIGNITE.—Lake basins filled with lacustrine and fluvio-lacustrine deposits of late Pliocene and Recent ages abound throughout Yunnan. To these deposits I have given the name "Nan Tien Series." Bands of lignite often occur in them and are sometimes mined for local purposes. The lignites are similar in composition and origin to those which occur in the basins filled with Tertiary silts in various parts of the Northern Shan States of Burma. One of these Shan coalfields is now being opened up by the Burma Corporation. I have not seen any seams in Yunnan which approach the Shan ones in thickness or regularity.

The following assays illustrate the similarity in composition of these brown coals:

Locality.	Moisture. %	Volatile Matter. %	Fixed Carbon. %	Ash. %	Remarks.
Nan Tien, Western Yunnan -	15·86	34·00	20·33	29·81	Mean of 2 assays.
Eastern Yunnan	19·94	34·39	27·72	17·95	,, ,, 7 ,,
North Shan States - -	16·55	36·62	35·11	11·72	,, ,, 18 ,,

TRUE COALS.—The earlier French writers established the existence of coal seams of Triassic and Middle Carboniferous age. The former occur mainly in the south-east of the province, and are of Upper and Lower Triassic age respectively, though there is one important field in Central Yunnan which probably stretches from the vicinity of Yunnan Hsien northward into the Yang-tze valley. In both regions it is mined and burnt by the local inhabitants. The Triassic coal of the Yang-tze valley is of excellent quality; low in ash and moisture, it has a high calorific value, burns with a brilliant flame, and yields a coke of very good appearance. I have examined also most of the important coal-bearing localities of the Middle Carboniferous in eastern Yunnan. They yield a semi-bituminous coal which cokes well, and the best seams are probably preferable for steam-raising purposes to the Triassic coals.

Yunnan coal has a future before it in the local market for metallurgical operations, domestic purposes, industrial uses, and as a fuel for the railways. I do not think that it will ever obtain a large market beyond the frontiers, owing to the land-locked position of the province, forming as it does the western hinterland of Continental China, and also to the hold which Japanese, Indian, Australian, and African coals have in the markets of the Far East in normal times.

IRON.—Iron ores are well distributed throughout Yunnan, and while none of the deposits appear to be extensive, or in any way comparable with, say, those of the crystalline rocks of the Indian Peninsula, yet iron-smelting is a settled industry, and all the large centres of population have their somewhat small needs of cast iron, wrought iron, and steel supplied from works in the same regions. Again, where any unusual demand has arisen, as in the case of cast-iron pans for the brine-boiling on the salt fields, there is generally an ironstone mine, blast-furnace, and foundry not far away. Yung-ch'ang Fu has its mines at P'ing-tai in the Ta-tien-pa valley, two stages to the east of the city. Têng-yüeh is supplied from the Tien-t'aung-kuan, a district which lies to the north. Yunnan Fu, the capital, has its requirements met from the Yi-men Hsien area; the cities of the south-east from the Hsi-o Hsien neighbourhood, and so on.

The hemispherical cast-iron pans of Yunnan are much appreciated by the Chinese everywhere, and may be found in all the bazaars of Upper Burma; while the thousands of mules engaged in carrying the trans-frontier trade are always shod with Yunnan-made shoes and nails, and every caravan carries a large stock of these excellent articles.

From Têng-yüeh to Ying-pan-kai, the centre of the iron industry of Tien-t'aung-kuan, is a three days' journey. The stages are at Ma-chan-kai, 14 miles; Ku-tung-kai, 23 miles; and Ying-pan-kai, 34 miles. The mines are situated at the head of a small valley about 4 miles from the village, which has an elevation of 6,000 ft. above sea-level. A fine-grained granite crops out in the vicinity, but geological observations were made difficult by a thick soil cap. There were a number of workings descending into a large mass of brown hematite. I traced the outcrop on the surface for 60 ft. without seeing its limits. It strikes a few degrees east of north and is from 10 to 15 ft. wide. The ore was carried down to Ying-pan-kai, where there were three furnaces, or to Ma-li-pa, three miles further north, where there were five. The furnace was of massive stone work, the back and sides forming a rough semi-circle. It was lined with a refractory white clay. It differed essentially from the high blast-furnaces used for smelting iron ores in other parts of Yunnan, as it was only 7 or 8 ft. high at the back. The blast was let in by a tuyere which entered the lower portion of the back wall. The blower, 7 or 8 ft. long and $1\frac{1}{2}$ ft. in diameter, was worked by a water turbine. The tapping hole was also used as the slag outlet until the hearth filled with molten metal. In front of the furnace a stone-paved incline sloped down to a tank filled with water, used for quenching the hot material at the end of the blow. Three rectangular holes in the upper part served as places where long iron rods could be introduced to prevent clogging. Charcoal and ore were added from time to time during the 24 hours which the smelting operation took. Two grades of material were produced, the first in the form of flat cakes of pig iron, and the second made up of the finely-divided iron mixed with a good deal of charcoal. The latter was worked up in forges into horse-shoes, nails, ploughshares, etc. The cakes of pig iron were used to make cast-iron pans. The furnace used for melting the metal was a small, round-bottomed, tilting blast-furnace about 4 or 5 ft. high, made of thick clay work, and strongly bound with iron bands. The molten metal was tapped into a ladle, and then poured into the moulds. The iron pans produced in this way were of beautiful workmanship and varied in diameter from 10 to 30 inches.

Mould Shed of an Iron Foundry.
(Note the piston of the cylindrical blower.)

Iron is smelted from ores obtained at several places in the vicinity of Sha-ch'iao, a small village four miles to the north-west of Chen-nan Chou. At Ye-cho-ho I examined a blast-furnace 25 ft. high, and 6 or 7 ft. across at its widest portion, narrowing to 3 ft. at the hearth and top. It was built of heavy stonework enclosed in beams held together by cross-pieces, and was lined with clay. The tuyere was cut from a block of hard sandstone. The blast was produced by the usual cylindrical blower worked by a turbine, on the principle of the vertical axled water wheels commonly used in the Himalaya for the supply of power to corn mills. The ores of this region are rather soft hematites derived from ferruginous horizons in the Red Beds series.

The P'ing-tai mines and smelters lie two stages to the east of Yung-ch'ang Fu. The ores are obtained from horizons in the Palæozoic limestones of the vicinity, and are treated in high blast-furnaces of an untapering type. The cast iron is worked up into bars of wrought iron for general smithy purposes, and there is also a foundry for casting iron pans.

In the Yuan-mou Hsien district, I heard of a mine at Yi-na-ch'ang, 5 miles from Lung-kai, a village on the main road between Ma-kai and Ma-an-shan.

There is an iron-stone mine at Lao-pe-ya, one stage from Têng-ch'uan Chou. Cast iron is made on the spot and turned into pans for use in the brine-boiling centres around Yun-lung Chou.

Hui-li Chou is supplied with iron from I-lang Ho, two stages west of the city, and also from a mine and smelter at Lao-ping-wan.

Near T'ieh-ch'ang, a village 4 or 5 miles to the north-east of Yung-p'ing Hsien, I found old iron slag heaps, but could obtain no information as to when they were made.

Iron ores are mined and cast-iron pans made at Lu-tzu, two stages north-east of Lu-fêng Hsien. These pans are used in the salt-fields around Lan-ching.

Hematite ores occur in bands in the Kaoliang slates between Mo-so-ying and Yi-men Hsien, and it is said that there is a large mine at Yang-hsing-ch'uan, a village on this route.

If Chinese evidence may be relied upon, one of the more important iron-producing regions of Yunnan is located around Hsi-shan-kai, which lies one stage north-west of Ta-tsang-kai, a large village near the head of the Mêng-hua T'ing valley, and about half-way between that city and Ta-li Fu. I was informed that the mines work all the year round, that they find employment for between 300 and 400 men, and that they supply the cities of Mêng-hua T'ing, Ta-li Fu, and Li-chiang Fu with the metal.

There are no iron ore deposits in Yunnan that I am aware of at all comparable in extent with those of the old crystalline rocks of India or Indo-China, and as the local demand is a small one, and not likely to increase very greatly, a large iron business would have to depend for its success on trans-frontier trade. The geographical position of Yunnan would make freight charges so high that even with railway transport available in all directions of outlet the local products would find it next to impossible to compete with French, Chinese, Japanese, and Indian manufactures in the Far East, and perhaps with European and American products landed on the coasts there. That a modern blast-furnace plant can be successfully operated in China is of course perfectly well known, but a situation such as the Hankow works enjoy does not exist in Yunnan. At the same time there is very considerable room for improvement in the local industry, but I am persuaded that this is a matter which may well be left to the small Chinese capitalist. Future progress in the way of systematic mining, more profitable utilization of the ores, and the closer association of the smelters with the coalfields of the province, if they come at all, will probably come through him.

HIGH BLAST-FURNACE FOR IRON ORES, YUNG-CH'ANG FU.

SALT.—The salt-producing beds of Yunnan occur toward the base of the Red Beds series of Permo-Triassic age. This series covers a great expanse of country, and the chief salt-manufacturing centres are situated in places where the lower horizons have been favourably exposed. The following prefectures all contain districts from which salt is obtained, and are arranged in order of relative importance:

(1) Chu-hs'uing Fu. Production 22,100 tons per annum from the districts of T'ing-yuan Hsien, Yao-chou, and Kuang-tung Hsien;

supplies the areas around the capital and towns as far south as K'ai-hua Fu and Mêng-tzu Hsien, with an estimated population of five and a half millions.

(2) Pu-erh Fu. Production 6,500 tons per annum from the districts of Chen-yuan T'ing, Wei-yuan T'ing, and Pu-erh Fu itself; supplies the south and south-western part of the province, both Chinese and aboriginal, estimated at one million six hundred thousand.

(3) Ta-li Fu. Production 3,600 tons per annum from the district of Yun lung Chou; supplies the towns of the Ta-li Fu, Yung-ch'ang Fu, and Shun-ning Fu prefectures, estimated at nine hundred thousand.

(4) Li-chiang Fu. Production 1,400 tons per annum from the district of Ho-ch'ing Chou; supplies the north-western corner of the province, estimated at three hundred and seventy-five thousand.

(5) Ch'eng-chiang Fu. Production 1,300 tons per annum, from the district of Ching-tung T'ing; supplies the surrounding country, estimated population three hundred and fifty thousand.

(6) Yunnan Fu. Production 600 tons per annum, from the district of An-ning Chou; supplies certain areas to the south, including Chiang-ch'uan Hsien and Hsin-hsing Chou, which have an estimated population of one hundred and fifty thousand.

(7) Ch'u-ching Fu. Production 400 tons per annum, from the Wu-t'ing Chou district; supplies the country around this town, with an estimated population of one hundred thousand.

This grouping follows more or less approximately the one adopted by the provincial salt administration. A broader classification based on geological and geographical grounds is the following:

(1) The salt fields of north-western Yunnan, including those of the Ta-li Fu and Li-chiang Fu prefectures.

(2) The salt fields of Central Yunnan, including those of the Chu-hs'uing Fu, Yunnan Fu, and Ch'u-ching Fu prefectures.

(3) The salt fields of south-western Yunnan, including those of the Pu-erh Fu and Cheng-chiang Fu prefectures. The fields of the Ching-tung district are about midway between those of Wei-yuan T'ing and Ting-yuan Hsien, but they are really an isolated portion of the south-western field.

It will be noted that all the salt-producing districts are east of the Mekong river. The total retail value of the 36,000 short tons of salt produced per annum in Yunnan I calculate to be about £288,000, and the total annual revenue derived by the Government at the time of my travels in the country about £170,500. It will be observed that the 36,000 tons of salt is consumed by a population of 9 millions, but it has been stated already that the population of Yunnan is about 11 millions. The question may be asked, where do the remaining 2 millions obtain their salt supplies from? In this connection it may be mentioned that the north-eastern districts are supplied from Ssu-ch'uan, that there are brine wells at Ya-ka-lo, a town 5 miles outside the Yunnan border in the extreme north-western corner of the province, and that there is a certain amount of illicit manufacture and contraband trade in salt in other regions. Salt is also made from brine at Yen-ching and Yen-tang in the Yen-yuan Hsien district of Ssu-ch'uan. These places are within short distances of the northern border of Yunnan in the Yung-pei T'ing district.

SALT IN THE TING-YUAN HSIEN DISTRICT. —The salt-producing localities in this district are Lan-ching, Hei-ching, and Hou-ching. At the former the salt is made entirely from the brine of five underground wells. A steep incline is driven down into the salt-bearing strata, terminating at the bottom in a well 60 or 80 ft. deep with a diameter of 5 or 6 ft. The salt is dissolved out by the water in the rocks, and, percolating into the well, is raised in a carrier of untanned buffalo skin worked on a primitive windlass, manipulated by four men. On reaching the top the liquid is emptied into a small tank excavated out of the rock. From here it is pumped to the surface as required. The pumps are made of hollow bamboos, from 4 to 6 in. in diameter, and from 8 to 10 ft. long, fitted with a piston made from a stick with a T-piece handle, to the other end of which a loosely-fitting plunger of skin packed with straw is attached. This is inserted inside the bamboo, which is open at both ends, and has one end dipping into the brine tank. A man sitting astride fills the bamboo with brine by means of a hand baler and then quickly works the handle up and down; the brine is sucked up and flows out at the upper open end into a small pool built at the side of the incline. From this pool another pump of the same kind lifts it a little higher, and the operation is repeated until the surface is reached. The brine now flows by gravitation in open wooden boxes to the storage tanks, which are generally sunk in the ground near the evaporating sheds. It is ladled out as required and carried in wooden pails to the sheds. These usually contain four furnaces, each fitted with 20 or 30 hemispherical iron pans varying from 2 to 4 ft. in diameter.

They are supported on iron bars covered with brickwork. The entire top of the furnace is filled in with brickwork up to the level of the tops of the pans. The brine is systematically treated; going first into a large central pan, it is heated, and then filtered, while hot, through cloth into a second pan. As it becomes more concentrated, it is transferred again and again, until solid cakes of salt are formed. When the furnace, which is heated with brushwood, is cool, the salt is taken from the pans, cleaned, and weighed. At intervals of a month or so the brick and clay work of the furnace is replaced, the old material broken up and leached with water to extract the salt which it contains.

Hei-ching is about 6 miles to the north-east of Lan-ching and the small town is built around its eight brine wells. Most of these are underground, similar to those in Lan-ching, though there are others which are open to the surface. The brine is won and treated by methods identical with those just described. Hou-ching is 12 miles to the south-east of Hei-ching, and it possesses several brine wells of the same type, and in addition three mines from which rock salt is won. The salt occurs in patches and strings in a hard red sandstone of considerable but unknown thickness, only about 20 ft. of it being mined. The sandstone is attacked in a methodical manner by driving large galleries into it, only sufficiently large pillars being left to support the roof. The rock containing the salt is smashed up and then leached with water, the brine being boiled down in the usual way. Some of the furnaces in Hou-ching are much larger than those in the other places, and are built to take over 40 small pans. The salt from all the localities is taken to the Government stores after being cleaned and weighed. It is there officially stamped with red paint, which, covering practically the whole surface of the mass, would show at once any attempt at pilfering by breaking off small pieces.

SALT IN THE YUN-LUNG CHOU DISTRICT. —All the salt which this district produces is made from well brine. There are no salt mines. The wells are located as follows: Pao-fung-ching, in the city itself; Shih-men-ching, Tien-erh-ching, Ta-ching, and Shang-ching, in a valley six miles north of the town; Lo-ten-ching, Lu-ching, and Shwun-tan-ching in the unsurveyed area to the north of Yun-lung Chou. At some of these places the brine is not evaporated to complete dryness, but the salt is removed from the pan while it is still wet, and firmly pressed into small cylindrical moulds, so that instead of the large masses made on other fields, which form a heavy load for a man, the salt comes on the market in the shape of small cylinders, each of about 3 lb. in weight.

SALT IN THE WEI-YUAN T'ING DISTRICT. —The geology of this salt field is much the same as the others, the mineral coming from a low horizon of the Red Beds series. At Hsiang-yen-ching there are two salt mines and two underground brine wells of the usual type with bamboo pumps. The boiling-down process is identical with that of the other fields. If anything, conditions are dirtier and more insanitary than elsewhere. The furnace houses are the homes of large families, and the gutters carrying the brine run along the village streets alongside the sewers. Ho-ti-tang has two salt mines which were opened about 1899. There are several other salt mines and brine wells in this region, but I did not succeed in obtaining a list of them.

SALT IN THE PU-ERH FU DISTRICT.— There are several salt-producing centres in this district, but I only visited one at Mo-hei. It is probably the largest in this part of Yunnan. Rock salt is mined and brine is obtained from wells. There are 28 evaporating sheds, and each furnace carries 24 pans in 6 rows of 4 each. About 300 miners and coolies are employed.

THE BRINE WELLS OF AN-NING CHOU.— This place is a small town one day to the west of the capital. Around it there is a considerable development of massive red sandstones and other rocks similar to those of the more important saliferous localities. The brine is very weak, and before being boiled down is concentrated in the following manner. It is led away in long open channels to shallow pools which expose as much of the liquid as possible and so favour evaporation. Beds of dried earth are arranged near these pools, and are periodically drenched with the salt liquors, which are baled out and thrown over them. Aided by the sun and the wind, the water evaporates, and the operation is repeated until the earth will take up no more salt. It is then leached with water in tanks, and the dirty solution so obtained is filtered through beds of charcoal, ashes, and sand, yielding a clear brine of much greater density than the original fluid from the wells. This is boiled down in the usual manner.

FUTURE OF SALT MANUFACTURE.—One of the most serious expenses of the industry is the cost of transportation from the manufacturing centres to the area of distribution, which is at present carried on by coolies or pack mules. The introduction of railways into the province will considerably reduce this. The output of salt in Yunnan appears to be slowly declining, a state of affairs readily understood when it is remembered that there are no workings which reach the deeper-seated deposits, and that the shallow wells have been worked so actively and continuously by the Chinese as to be now in a condition verging on exhaustion. Everywhere in the province the same story is told, a story of the former prosperity and the present depression of the salt-producing centres. The output could be greatly increased by the introduction of simple machinery, especially for pumping and quick transmission of the brine. I also believe that drilling would probably reveal the existence of salt-bearing horizons of the Upper Permian in places at present unknown to the Chinese, where they are lying buried under considerable thicknesses of later Mesozoic strata. Salt is everywhere under the strictest official control and is taxed at every stage, in its manufacture, purchase, at the vats, transport, sale at the depot, and sale to the people. The importation of salt from Burma into Yunnan is prohibited by the Burma-China Convention of 1894-1897.

MERCURY. — Cinnabar probably occurs in Yunnan; several specimens were shown to me at various places, though some of them may have come from the well-known mines in the neighbouring province of Kuei-chou. At Yun-lung Chou I heard of a cinnabar mine three or four days' journey away to the north, but I was not able to prove the accuracy of the information. According to Rocher, several cinnabar deposits were worked in the Ta-li Fu prefecture before the rebellion. He describes the roasting of the ores and the method adopted to condense the mercury vapours.

ANTIMONY.—Stibnite occurs in the Kai-hua prefecture and also about Kwang-nan Fu on the borders of Kwang-si. From time to time a few hundreds of tons of antimony regulus are exported from these places through the Mëng-tzu customs.

MARBLE. — Ta-li Fu marble is famous throughout China and is used for decorative purposes. The quarries are on the high mountain wall a few miles to the north-north-west of the city. A crystalline marble crops out in them. It is a fine-grained variety with irregular lines and spots of dark micas and amphiboles in a white background, which produce fantastic effects and are much appreciated by the cultured Chinese. Large quantities of the stone are still available, but the industry is controlled by the dealers rather than by the quarry owners or polishers. The stone is prepared locally, and is often stained artificially and then covered with a coating of wax to hide the deception and emphasize the colour design.

SEMI-PRECIOUS STONES. — The jadeite which is worked up in Têng-yüeh comes entirely from the mines of the Mogaung subdivision of the Myitkyina district in Burma. The best qualities are said to be exported direct in the rough to Canton and only the second-grade stone is sent to Yunnan. Nevertheless, jade-cutting and polishing is a staple trade in Têng-yüeh where every street has a lapidary's shop and lathe. Dealing in this mineral is very speculative, as the valuable apple green shades are often not visible on the outside of the boulders.

Amber ornaments are common. Most of the specimens I have examined bore the characteristic fluorescence of the Burmese material.

Turquoise ornaments are always worn by the Yunnanese Tibetans, but the stone is not of local origin.

CONCLUSION. — Longer accounts of the mineral deposits described in this paper may be obtained from Vol. xlvii, Pt. I, Memoirs of the Geological Survey of India.

Mr. E. A. Cappelen Smith.— The Mining and Metallurgical Society of America's gold medal for the year 1920 was presented to Mr. E. A. Cappelen Smith for distinguished service in the art of hydrometallurgy at a dinner held in New York on October 10. Speeches were made by Dr. Arthur L. Walker and Mr. Harry F. Guggenheim. Dr. Walker told of the coming of Mr. Smith to America from Norway, his native country; his wanderings, following his profession as a metallurgist, to Anaconda and other parts of the West; then finally back to the East Coast; how he built up a reputation as a progressive and courageous metallurgist, which finally led to his being selected to solve the treatment problems of the great Chuquicamata ore-body, in Chile. Mr. Guggenheim sketched the history of the ore deposit at Chuquicamata, telling how it had been known for hundreds of years; how it had first been worked by the Incas and, after the conquest, by the Spaniards; how the rich ores had been exhausted, and though the colour of the rock proclaimed to every comer "Here is copper," it awaited the touch of adventurous science to transform the desert into the abode of industry. This had been accomplished by the scientific staff of M. Guggenheim's Sons, and in this work the solution of the metallurgical problem by Cappelen Smith was one of the most important features. As the result, plants capable of treating 10,000 tons of ore a day, from an ore reserve that would last over a hundred years, have been constructed.

GALLOWAY'S PORTABLE MINING MAGNETOMETER.

Particulars are here given of an instrument, called the Magnetic Reflector, invented by T. Lindsay Galloway.

THE weekly reports showing the mean magnetic declination for each two-hour interval, as recorded at Kew Observatory, have now been issued for nearly three years. To the engineer or surveyor these reports have an educative value in familiarizing him with the daily and hourly changes in the direction of the magnetic meridian, a subject little understood before, except in purely scientific circles. It is now well known that in each period of 24 hours the direction of the meridian undergoes a complete cycle of changes, generally of regular recurrence, but subject to sudden disturbances. The ordinary magnetic needle is not sufficiently sensitive to respond to all those ceaseless fluctuations, and, to the casual observer, most of them are hardly perceptible; but we know that they may be of sufficient importance to cause very grave errors when not taken into account in fixing the orientation of a survey or plan by means of the magnetic meridian. The instruments in use in magnetic observatories are too delicate and also too expensive to be suitable for the requirements of the practical surveyor, but Mr. T. Lindsay Galloway has invented a portable mining magnetometer which cannot be deranged by any ordinary handling and which responds accurately to all the changes in the direction of the magnetic meridian. This instrument has been designed specially for the use of engineers and surveyors, and it is manufactured by the old-established firm of instrument makers, Messrs. T. Cooke & Sons, Ltd., of York. Mr. Galloway described his system in papers read before the Institution of Mining Engineers, which were quoted in the MAGAZINE for October, 1918, and October, 1920. We are now able to give a detailed illustrated account of the instrument.

Externally, the instrument consists of an oblong box of circular section. In the interior a suspension is fixed consisting of a fibre of unspun silk. One end of the fibre is attached to the stem of a flat mirror, carrying a bar magnet. The other end is attached to the stem of a pendant, of exactly the same weight as the combined weight of the mirror and magnet. The stems of the mirror and pendant, with the fibre outstretched between them, are held in position, when the instrument is not in use, by clamps, which can be operated from outside the box. Suitably-placed windows are provided at each end of the box, through which the mirror and pendant can be observed.

In using the instrument, the box is first set up on end, with its axis vertical, that end in which the mirror is situated being uppermost and the pendant below. The pendant is unclamped and allowed to turn freely until it comes to rest, so that all twist in the fibre may be removed. It is then clamped and the box inverted, so that the pendant is uppermost and the mirror below. The mirror is now unclamped and would begin to oscillate, probably through a large angle, by the influence of the earth's magnetism upon the attached magnet. But its movements are restricted by a pair of stops which prevent it from swinging through more than a very small fraction of a revolution. The box itself must now be turned, if necessary, about its vertical axis, until the mirror is seen to oscillate freely within the restricted limits allowed by the stops. When it comes to rest the axis of the magnet will be in the plane of the magnetic meridian.

The details of the instrument are shown in the illustrations on the next page. Fig. 1 is a general view reproduced from a photograph, Fig. 2 is a front sectional view, and Fig. 3 is a side sectional view, with cross sections showing the clamps. P is the pendant, f f the silk fibre, M the mirror, with the bar magnet, b, attached. The stem of the pendant, as shown in the cross-section through AA^1, is secured between two bars, one of which is fixed and the other is part of a movable stirrup, which can be made to travel horizontally in either direction by turning a milled head. The surfaces of contact between which the stem of the pendant is held are straight, parallel to each other, and perpendicular to the direction of motion of the stirrup, so that when the latter comes into contact with the stem of the pendant, in the act of clamping, there is no tendency to produce rotation. The mirror is secured by a clamp similar in general design, but the stem is provided with flanges above and below the clamp, to prevent end travel, and the stem is so shaped as to fit into a notch in the clamp as shown on the cross-section BB^1, so that the mirror may be always retained in approximately the same position in the box.

This instrument, which has been named a Magnetic Reflector, is intended to be used in conjunction with a theodolite to determine the direction of the magnetic meridian accurately at any given time. Assuming that it has been set up on its tripod, and that the mirror, after having been released, has come to rest in the plane of the meridian, the problem is to determine its direction by means of the theodolite. Two methods of doing this have been described by the inventor. According to the simpler method, the theodolite is set up directly in front of the Reflector. A plumb-line is suspended below the centre of the theodolite, and its reflected image, seen in the mirror, is brought into exact coincidence with the cross wires in the telescope, which of course will bring the line of vision exactly perpendicular to the face of the mirror. It is not difficult to find approximately the spot at which the theodolite should be set up, by holding any white object (or a lamp, if working underground) and looking for its reflection in the mirror. A little shifting of the theodolite afterward, and adjustment by the tangent screws, is sufficient to bring the image of the plumb-line and the cross wires into exact coincidence, which is all the more easily accomplished if the theodolite has a centering device. With regard to the distance required between the theodolite and the Reflector,

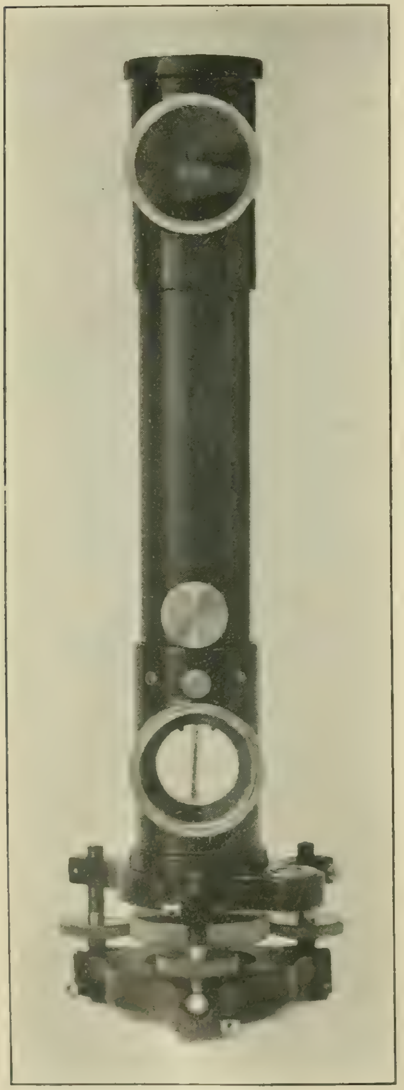


Fig. 1

Fig. 2.

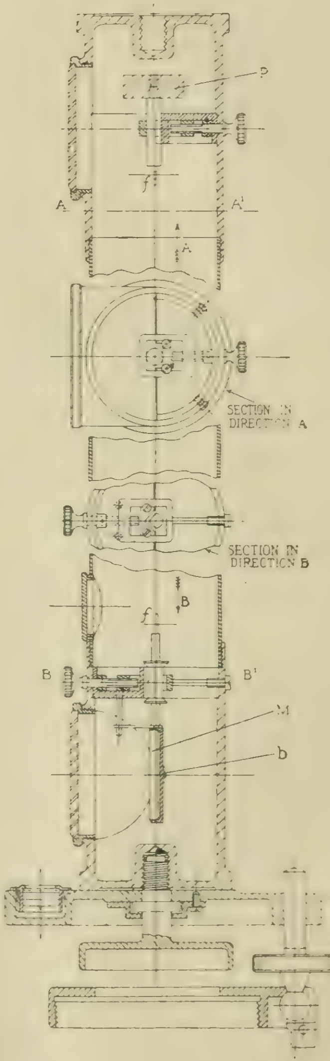


Fig. 3.

it is quite possible to obtain sharp definition at 5 or 6 ft., as the rays of light from the plumb-line require to travel double the intervening distance, namely, from the plumb-line to the mirror and back to the eye of the observer. To obtain the direction of the meridian it is only necessary now to turn the theodolite round through 90 degrees.

Another method of finding the meridian when the theodolite used has little or no centering motion, or when unable to rig up the theodolite directly opposite the magnetic Reflector, is to proceed as follows: Place the Reflector on one of the tripods, adjust it by the levelling-screws, set free the mirror, and allow it to swing until it comes to rest in the plane of the meridian. Place the other two tripods, each having a plumb-line suspended from its centre, at convenient distances in front of the Reflector; not *directly* in front, however, but somewhat to each side, and far enough apart to admit of distinct focussing when a sight is taken from one to the other. Place the theodolite on either of the tripods and cause the other to be moved, if necessary, until the image of its plumb-line can be seen reflected in the mirror. The following observations are now to be made, and at each observation the cross-wires in the telescope must be brought into exact coincidence with the image of the plumb-line, whether viewed direct or reflected, as the case may be.

Referring to Fig. 4, A, B, C, represent the tripods, B being the one which carries the Reflector. Place the theodolite at A, turn the zero toward B, clamp the axis, and turn the instrument through the angle BAC; clamp the vernier, unclamp the axis, and remove to C; turn the instrument toward A. The zero will now lie in the direction CD, parallel but opposite to the original direction AB. Clamp the axis, unclamp the vernier, and turn the instrument toward B. The angle now recorded on the horizontal circle is to be noted. It is evidently the angle DCB. If the instrument be turned back through half this angle, the centre-line of the telescope will be parallel to the face of the mirror, and therefore in the plane of the magnetic meridian. The graduation of the theodolite has been assumed to be in clockwise direction. If otherwise, the order of procedure is to be reversed. The process, it will be seen, is extremely simple, and geometrically exact. Having determined the magnetic meridian, the surveyor may proceed with the remainder of the survey in the usual manner, and can check the meridian line at any other suitable point by repeating the same process.

What is generally required, however, by the practical surveyor, is not the actual direction of the magnetic meridian, which, as we know, is continually changing, but the relative direction of two lines, one of which is usually above ground and the other below ground, upon which the correct orientation of two plans or surveys depends. We know that, notwithstanding the constant alteration of the direction of the meridian, it returns, except when there is a magnetic storm, day after day to nearly the same position at the same hour. Therefore by making a series of observations on successive days at corresponding hours, a very accurate determination of the relative bearings of two base lines may be made. A still more accurate method is to make a series of simultaneous observations at the two bases, as described by Mr. Galloway in his recent paper read before the

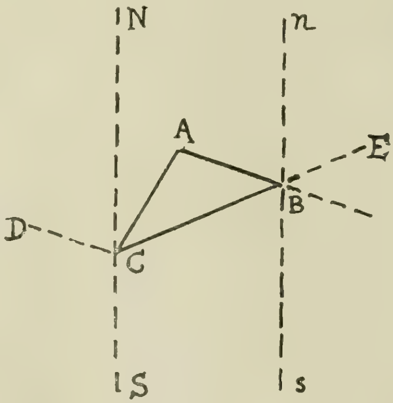


Fig. 4.

Institution of Mining Engineers, at Manchester, on September 15, 1920. [See the MAGAZINE for October last]. In this case the effect of the ordinary diurnal variation of the earth's magnetism is entirely eliminated. During a violent magnetic storm earth currents might, of course, cause disturbances, but this is at present rather an obscure subject, which requires further investigation. In the meantime the careful surveyor should avoid magnetic storms.

In order to check the oscillations of the mirror quickly it is convenient to use a permanent magnet. The observer standing in front of the Reflector should watch the edge of the mirror approaching him in its swing, and at the correct moment should present the same pole of the magnetized bar in his hand to that of the end of the needle (at the back of the mirror) nearest to him, thereby repelling and quickly checking the oscillation of the latter.

THE EXAMINATION OF MILL FLOW-SHEETS.

By R. T. HANCOCK, Assoc.Inst.M.M.

The author discusses the efficiencies of machines used in tin-dressing, basing his arguments on figures obtained at East Pool.

THE publication of the East Pool flow-sheet, with tonnages and assays attached to some of the processes, in Professor S. J. Truscott's supplementary paper, read before the Institution of Mining and Metallurgy, on "Slime Treatment on Cornish Frames," and a similar flow-sheet of the same mill in THE MINING MAGAZINE of December, 1917, enables an analysis of the performance of the different machines to be attempted.

The practical difficulties of obtaining accurate figures are very great, and anything like a complete tie-up is not to be expected. The best that can be hoped for are figures representative of average performances. The efficiency of a process performed on a given machine is so completely dependent on the tractability of the feed, that if comparative figures for similar machines and processes were obtainable from different plants, where the ores and general lines of treatment differed, the figures could not be taken as establishing a superiority of the practice in one mill over another.

Examining the published figures referred to above, it soon becomes evident that they are not in themselves very reliable, but as the only ones in existence they are at least a step towards the systematic examination of Cornish milling practice, and if rigorously accurate figures were insisted on, the probability is that no data would ever appear.

As given by Truscott, the treatment in the sands section of the East Pool mill consists of the separation of the sands from the slimes by a single spigot classifier in front of the stamps, their treatment on Wilfley tables with the production of a concentrate sent to the calciner, a tailing sent to waste, and a middling sent to Frue vanners via a tube-mill and classifier circuit, being joined en route by a product from the calciner.

Tonnages and assays are not given for all the products, but sufficient are given to enable the missing ones to be calculated, and in order to tie up it is required that the sand tailing rejected by the Wilfley should have an assay of 2·8 lb. Sn per ton only. It is hardly possible that such a figure is attained in practice.

A further examination of the whole flow-sheet shows that a total of 21 tons per day is given as sent to the calciner, while on the other hand products totalling 25 tons are daily received from the calciner and incorporated in the flow, again an impossibility.

The figures for the Wilfley tables published in the MAGAZINE show both tonnage and assay figures for all products, the tailings to rejection being stated at 4 lb. Sn per ton, but the figures do not tie up, and 500 lb. of metal daily vanishes altogether.

On the figures given and derived from Truscott's diagram the performance of the sands section, consisting of Wilfleys, the tube-mill and classifier circuit, Frue vanners, and the flat frames of No. 2 slimes plant, is as follows:

	Tons	Lb. per Ton	Total Tin Lb.
INTAKE.			
From			
Classifier.........	173	26	4,498
Calciner	10	28	280
Total	183	26·1	4,778
OUTGO.			
To			
Calciner	10	269	2,688
Calciner	5	291	1,456
Round Frames	10·4	12	125
Slimes Section...	15·7	7	110
Waste	141·9	2·8	388
			4,778

The total recovery in the shape of a product ready for calcining is therefore 86·7%, the concentration 8·2%, and the efficiency of the section 78·5%.

Taking the performance of the Wilfleys by themselves:

Feed .... 173 tons averaging 26 lb. per ton
Concentrate ... 10 tons averaging 12% (to calciner)
Tailings (including middlings sent to tube-mill and vanners) averaging 11 lb.

Recovery..............................	60·0%
Concentration	5·8%
Enrichment	10·35
Efficiency	54·2%

The figures for the vanners by themselves, which are fed from the classifier in circuit with the tube-mills treating the Wilfley middling and calciner product, as well as the sandier portion (re-ground) of their own tailings, are as follows:

Feed .... averaging 25 lb.
Concentrate............ 5 tons averaging 13%
Tailing .... averaging 8 lb.

Recovery..............................	70·0%
Concentration	6·0%
Enrichment	11·65
Efficiency	64·0%

The slimes from the classifier in front of the stamps are treated on flat frames as follows:

Feed...57 tons averaging 23 lb.
Concentrate...averaging 28 lb. (to Round Frame)
Tailing ...... averaging 15 lb. (to Taylor Table)

Recovery	75·0%
Concentration	61·5%
Enrichment	1·22
Efficiency	13·5%

The round frames taking these concentrates operate as follow:

Feed .... averaging 28 lb.
Concentrate (to dead buddle) averaging 60 lb.
Tailing...... (to round frames) averaging 20 lb.

Recovery	42·8%
Concentration	20·0%
Enrichment	2·14
Efficiency	22·8%

These concentrates are treated in the dead buddle as follows:

Feed .... averaging 60 lb.
Concentrate ...... (to calciner) averaging 6%
Tailing .... (to frames) averaging 30 lb.

Recovery	64·1%
Concentration	28·7%
Enrichment	2·24
Efficiency	35·4%

So that the combined result of the three foregoing processes carried out in obtaining from the overflow of the battery classifier a concentrate fit for calcining, is as follows:

Recovery	20·5%
Concentration	3·5%
Enrichment	5·85
Efficiency	17·0%

The combined assay of the tailings, which are further treated on tables and frames, is 18·9 lb. per ton.

The classified tailings of the Frue vanners of the sands section are treated on flat frames as follows:

Feed .... averaging 9 lb.
Concentrate...................... averaging 12 lb.
Tailing .... averaging 7 lb.

Recovery	53·3%
Concentration	40·0%
Enrichment	1·33
Efficiency	13·3%

These concentrates are re-treated on round frames as follows:

Feed........................ averaging 12 lb.
Concentrate .... averaging 30 lb.
Tailing..................... averaging 7 lb.

Recovery	54·5%
Concentration	21·8%
Enrichment	2·5
Efficiency	32·7%

The combined effect of these two stages in producing a 30 lb. concentrate from the vanner tailings is as follows:

Recovery	29·1%
Concentration	8·7%
Enrichment	3·33
Efficiency	20·4%

The above flat frame concentrate was the subject of experiment by Truscott on a laboratory flat frame, and was treated with efficiencies up to 50% and over. The material used by him (East Pool No. 1) had an original assay of 2%, and possibly differed in other respects.

The tailings from the flat frames are shown in the flow-sheet as treated on Taylor tables, but no figures are given by which the performance of these can be gauged. The issue of the MAGAZINE already mentioned contains a description of runs on this table from which the following figures can be calculated.

Test No.		Conc. %	Midd. %	Tail. %
1.	Recovery	51·4	9·4	39·3
	Concentration	15·0	15·0	70·0
	Efficiency	36·4	−5·6	−30·7
2.	Recovery	49·0	18·5	32·5
	Concentration	16·0	20·0	64·0
	Efficiency	33·0	−1·5	−31·5
3.	Recovery	55·6	11·9	32·5
	Concentration	17·5	17·5	65·0
	Efficiency	38·1	−5·6	−32·5

Under the conditions of the tests, then, these tables operated with an average efficiency of 35·8%, which may be compared with the efficiency of 32·7% obtained on the ordinary round frame treating the concentrate of the flat frames, whereas the Taylor tables operate on their tailing. No comparison of the merits of the two tables can be made, but an impression is left favourable to the Taylor table.

The material sent to the Taylor tables in the flow-sheet was tried by Truscott on a laboratory flat frame (East Pool No. 2) with efficiences up to 25%.

The efficiency of the whole mill up to the calcination stage calculated from the flow-sheet given by Truscott, and incorporating the calciner products returned to the flow, is as follows:

Recovery	72·2%
Concentration	7·9%
Efficiency	64·3%

The mill tailings to this stage consisted as to 141·9 tons of sand tailing at 2·8 lb., and 93·1 tons of slime tailing at 15·0 lb. per ton.

A few figures relating to the results obtained in the treatment of the calciner products can be got from the data published in the MAGAZINE. The spigot product of the classifier taking the calcined slime is treated on James sand tables at an efficiency of 50%. The overflow of this classifier is treated on James slime tables, the tailings of which are treated on a round frame at an efficiency of 15%. The calcined coarse product is buddled in No. 1 buddle, the head of which is treated in No. 2 buddle at an efficiency of about 34%.

An examination of a flow-sheet in the foregoing way serves to bring into prominence the low efficiency at which many of the stages are conducted.

NEWS LETTERS.

KALGOORLIE.

October 5.

HAMPTON PLAINS.—After the boom on the new Hampton Plains, St. Ives, and Mt. Monger fields, the usual collapse has hit those who wanted to make money quickly. Many of these bought shares in new companies which were floated on properties which had not even a lode, much less a payable one. The result has been that as most of these were no-liability companies, the shareholders ceased paying up calls, and the wild-cats are dying rapidly. Those companies that are developing their lodes, and meeting with more or less encouraging assay-values, are able to keep going. The Celebration company is concentrating all its energies on sinking the main shaft, which is now down 198 ft., and as soon as the connection is made with the 193 ft. level, and the pumps are ready, it will be pushed on to 300 ft. to test the lode in the sulphide zone. Complete winding and compressing plants, the latter driven by a suction gas engine, are being erected, and the results of the next few months' work will be watched with very keen interest. What is believed to be a continuation of the Celebration lode has been cut, carrying encouraging prospects, in the Hampton Properties reserve lease No. 81, which is south of the Mutoroo, but the strike brings it to the west of the Mutoroo line of lode. The Mutoroo company, which has been reporting high-grade ore for some months past and crushed 310 tons for a return of 47 dwt. of gold per ton to confirm these assay-values, has been reported upon by Mr. de Jersey Grut, of Kalgoorlie, very adversely. He points out that the high-grade ore occurs in two flat pipes, 15 or 20 ft. in length, and that there is no continuous run of good ore away from these pipes. He further says that "the shafts have been turned on the underlay, and the winze below the bottom level is not only following the dip of the ore-body, but has also been turned to follow down on the pitch of the rich shoot. While admitting that the merits of this form of development are debatable, it is one that in an excited market may lead to a misunderstanding of the true position of the mine, unless particular care is taken to inform the shareholders of the methods that are being adopted." This shows how in a boom period bad mining practice is carried on in order to keep the market value of the shares high, which eventually leaves an opening for a bear raid when the actual position becomes known. Curiously enough, on the same date as the above report was published, the *Kalgoorlie Miner* stated that the position of the Lass o' Gowrie appears to be enveloped in mystery. Following upon a series of highly favourable reports, the directors obtained an independent report, and, although this has never been published, its nature is indicated by the fact that the scrip suddenly fell 50% on the market. Local shareholders feel that the report should have been made public immediately. This mine, which is at Mt. Monger, was referred to in my last letter as having been floated into a company with a large capitalization without a report having been made on it by any accredited mining engineer. The representative of one of London's leading financial papers, who is a remarkably sound mining journalist, was given a very hostile reception at Kalgoorlie when he warned the public to be cautious about this and other mines in the vicinity. Now the same public wishes it had taken the advice of a man who was game enough to preach prudence during a boom.

The one mine at Mt. Monger which has, as far as development work shows, carried consistently good ore values is the Mt. Monger Proprietary. The extension of this ore-body has been cut in the Great Hope mine 120 ft. farther north at the 100 ft. level, where it maintains its high grade.

On Hampton Areas Block 48 the White Hope lode where cut in the cross-cuts at the 100 ft. level from the No. 2 and 3 shafts was narrow and of lower grade than at 40 ft., and with shorter shoots of ore than was anticipated. However, on driving north, ore of better grade has been cut, and the lode in No. 1 shaft, which is the most northern, is improving on sinking to the 100 ft. level, where in the cross-cut 13 ft. of ore has been exposed worth 14 dwt. per ton. The development of this property is much slower and more expensive than the Celebration, as it is in hard sulphide ore (amphibolized quartz-dolerite) from the surface, whereas the former was in oxidized ore to a depth of nearly two hundred feet.

The Golden Hope, which lies between the above two mines, is the third property on the field on which a settled policy of development work is not only warranted but is being carried out. A main shaft is being sunk to a depth of 100 ft. to develop the sulphide lode, which is more like the Kalgoorlie ore-bodies than either of the other mines at Hampton Plains. The evidence so far as this field is concerned seems to point to the greater similarity of the ore-bodies to those at the north end of Kalgoorlie rather than to those on the Golden Mile. Further evidence at depth is still required before any definite statements can be made on this question. The field is now connected with Boulder by means of the Firewood Company's railway line, so that trial lots of ore can be sent to Boulder for treatment. At St. Ives, a field south-east from Hampton Plains and across Lake Lefroy, rich patches of ore containing several hundred ounces of gold have been found as contact deposits, and on the parent mine, Ives Reward, at a depth of 60 ft. the lode is reported to be worth an ounce to the ton over 20 ft. in width. Further development by driving on the lode is needed to see the length of the shoots of ore. Mr. de Courcy Clarke, Assistant Government Geologist, is at present making an examination of this field, and as the present Minister for Mines believes in publishing interim reports on the work of the survey (unfortunately now reduced to three geologists and one draughtsman) the speculating public will have something more definite to go upon. On my brief examination of the St. Ives field some months ago, I found similar rock characteristics to the Golden Ridge line of lode, which is some seven miles south-east from Boulder, where the enrichments occur at the intersection of the cross reefs with the main series of quartz, quartzite, and jasper lodes. Some eleven miles further south there are long shear zones of quartz-porphyry striking north and south, and here again cross veins of quartz cause enrichments in the foliated quartz-porphyry, but nothing of permanent value has been found. Quite a lot of prospecting work is being carried out around Widgiemoultha, where the lodes consist of hornblende schist in which occur quartz veins running with the schist, and in these the gold occurs often in rich patches but of no great extent.

INCOME TAX.—The assessors of the Federal Income Tax Department have had many little jokes of their own, but in cases where the recipients are in a position to act together and fight the matter the Department generally modifies their demands. When, however, it is the poor unfortunate prospector who perhaps after 25 years living the hardest of lives with the fewest of comforts, finds and sells a mine say for £6,000, the Department calmly announces that it wants 33% tax on this. Now, however, one of these men has refused to see the little joke and intends to fight the matter.

If a farmer buys his holding for £1,000, and after ten years he sells it again for £10,000, he has not to pay any income tax, because it is an appreciation of his capital. The prospector's capital is his labour and knowledge and experience gained thereby, which with a bit of luck gains him the £6,000 when he sells his mine, but he is called upon to pay £2,000. The *Kalgoorlie Miner*, which has always fought for the prospector's interests, has secured the promised assistance of the State Minister for Mines (Mr. J. Scaddan) to have this matter reviewed by the Federal Government. Otherwise, if this form of taxation is persisted in, it will have the effect of wiping out prospecting in this State, and if the prospector disappears, the mining industry will not long survive him.

WESTONIA.—At Westonia, now that the Edna May company has shut down and withdrawn its pumps, the other mines are unable to carry on the burden of pumping. When these mines were found, it was suggested in these notes that the only sensible policy to pursue was to amalgamate the Edna May, Edna May Deeps, and Edna May Central, sink one main shaft in which a large pumping plant could be put, capable of handling all the water, one treatment plant, and one management and board of directors. However, the directors of the several companies thought otherwise. The result is that the Edna May paid good dividends while the lode remained in its ground and pumped nearly all of the water; meanwhile the other companies have been crippled with the cost of separate plants, and directors who could not see the wisdom of working together. Now almost at the last gasp, and when the pumping plant has been withdrawn from the Edna May shaft, the other companies propose that a 20-in. Cornish lift be put in so as to save their mines from being flooded. The cementation process used on the Deep Levels was effective while shaft-sinking was in progress, but it is not suitable when it comes to stoping. At present it is impossible to break the rich ore in the mine at the No. 5 level, because it is damming back the huge reservoir of water in the Edna May workings at No. 4 level.

KALGOORLIE.—The mines at Boulder are struggling on with smaller outputs owing to scarcity of men and decreased tonnage broken due to the shorter hours (44) worked per week. Every day means higher costs for stores and repair parts, so that were it not for the premium on gold most of the big mines would have to shut down. To-day the Arbitration Court starts the hearing of the plaint of the Workers' Union, which asks for a minimum of 20s. 4d. for machine miners, 19s. for truckers, 23s. for mechanics, and 15s. for boys under 18 years of age; not more than 40 hours' underground work per week starting from the surface and being returned thereto in 8 hours; treble rates for Sunday, and other sorts of penalties; abolition of night shift; and all employees to be employed through union office. As this case is sub judice it is unwise to make any comment; in any case it would be hard to find words to express it adequately. C. M. HARRIS.

BRISBANE.

September 18.

IRON AND STEEL WORKS.—The Government of Queensland, in pursuance of the nationalization policy of the Socialistic, or Labour, party of that State, have, since their party came into power over four years ago, launched quite a number of State enterprises. In addition to a State battery at Bamford for the treatment of the rare metals, the Chillagoe smelting works and railways, and the Irvinebank tin-smelting works, they have also a State arsenic mine, State assaying offices at Cloncurry and Mareeba, State pastoral stations, butcheries, fish markets, and insurance office. Their latest and biggest venture is a State iron and steel works, which are to cost anything between £2,000,000 and £3,000,000.

A general manager for this new venture was appointed over eighteen months ago, and toward the beginning of this year it was decided to go on with the works. The site chosen for these is the port of Bowen, on the east coast of Australia, some 700 miles north of Brisbane. Bowen has a good harbour, and the town is picturesquely situated right on its shores, but, for some reason or other, the place has always been, with one or two exceptions, the slowest and least go-ahead centre on the Queensland coast. The selection of the site, some of the Government's opponents are unkind enough to say, has not been altogether free from political influences; but it is claimed, on the other hand, that after the fullest investigation and consideration the position on the Bowen harbour (Port Denison) was chosen as the best available for the assemblage of the commodities needed in steel manufacture (iron ore, coal, manganese, and limestone), and as offering the best facilities as far as shipping is concerned.

Bowen, however, is in the tropics (on the 20th parallel of latitude), and one real obstacle to be expected will be that of labour, the difficulty of obtaining a large body of white men to live so far north and work at the iron-smelting furnaces in such a hot and moist climate as that of Bowen.

The new works are to have a capacity of 130,000 tons of iron and steel per annum, and are, it is promised, to be the most up-to-date in the world. They will embrace a 350 ton blast-furnace, four 60 ton basic open-hearths, blooming, rail, structural, merchant, rod, nail, and sheet mills; fish-plate and galvanizing plants; a coke-oven plant with 60 ovens; a by-product plant, and a slag-cement plant. It was expected that this machinery would be ordered from the United States, but the high rate of exchange prevailing is compelling the Government to look elsewhere for it, and it was some time ago stated that the whole plant would be obtained from Great Britain and Australia. One thing that has been causing delay in Queensland is that the Government have not known how or where the money for the proposed works is to be got, and this is a matter about which the Premier of the State lately visited London. Although the London financiers turned down his proposal for a large loan, intended to cover the cost of the proposed iron and steel enterprise and other public works and ventures, the Government are confident that the money wanted can be obtained in the State and are continuing all the preliminaries that have been in train for some time.

The principal Queensland iron ore supplies are to be drawn by railway from the Cloncurry district, about 600 miles inland from Bowen. The ore in this far western locality is in two mountains, one (Mount Philp) containing 120,000,000 tons and the other (Mount Leviathan) 20,000,000 tons of hematite, above the ordinary level of the surrounding country, and consequently easily mined in both cases, with the probability of a good deal more to be obtained by mining below the base of the mountains. The ore, as assayed, ranges from 52·8 to 62% of iron, is low in phosphorus (from 0·023 to 0·11%), and sulphur (from 0·006 to 0·05%), but somewhat high in silica (from 8·9 to 23%). With the silica the manager does not expect any difficulty, as it is intended to convert the blast-furnace slag into cement. There are smaller deposits of iron in other parts of Queensland, including one at Biggenden (inland from Maryborough) of 500,000 tons of high quality and self-fluxing, and another at Iron Island (on the coast off Rockhampton), whence at present the Mount Morgan company obtains its ironstone flux.

The coal for the proposed works is to be got from the Bowen River coalfield, which is being opened up by the Government, and where there are two large seams of good coking coal. The field is distant sixty miles from Bowen, and is being connected with that port by a railroad that should be finished before the ironworks are ready for a start. The coalfield is many square miles in extent, and over a considerable area is estimated to be capable of supplying great quantities of coal in clean broad seams.

Whether the iron deposits of Queensland are sufficiently extensive alone to warrant the establishment of big iron and steel works in the State is a question of which considerable doubt has been expressed, and it would seem that the Government itself has had some misgivings on the subject, for just after the Bowen site had been selected they obtained from the lessee an option over the iron deposits on Yampi Sound, on the north-west coast of West Australia, about 600 miles south of Darwin and over 2,000 miles by sea from Bowen by way of Torres Straits. In this deposit there are at least 20,750,000 tons with a metallic content as high as 68·99%, mostly available by means of quarrying, with the probability of large bodies obtained lower down by mining and dredging from the bottom of the sea close to the precipitous shore from which it has fallen. If the right to this deposit (for which the holder asks about £30,000) is secured, it is intended to blend the West Australian ore with that from Cloncurry. The option for the purchase of this deposit expires in October, 1920, and it is expected that the Government will then purchase or obtain an extension of the option. [This option has been exercised. The deposits were described in the October issue.—EDITOR.]

The future of the national iron and steel business depends on the ability of the Government to raise the funds. At the present time the State has a Labour Government with crude ideas of finance, and attempts to float loans in Great Britain have been failures so far.

The only other iron and steel works of any importance in Australia are those of the Broken Hill Proprietary Co., Ltd., at Newcastle, New South Wales, which at present are overtaxed with work, have a ready market for all that they can produce, and are about to make large additions to their present plant.

MELBOURNE.

September 30.

MELBOURNE UNIVERSITY.—A few months ago I referred to the parlous position of some of the Universities in Australia arising from the increased cost of administration and also from the larger number of students presenting themselves. Australia is not alone in this predicament, for Great Britain, Canada, and the United States, not to mention other countries, are confronted with the same difficulties and problems. Sir John H. Macfarland, Chancellor of Melbourne University, has issued an appeal for a public subscription of £100,000. I quote some of his points herewith: "That the people of Victoria realize the importance of a University education for their sons and daughters is shown by the great increase in students from 646 in 1904 to over 2,400 in 1920. That here, as everywhere else in the Empire, this realization has been quickened by the lessons of the war is shown by the fact that there is in 1920 an increase of nearly 1,000 students over the years 1914 and 1918. What citizens have recognized as individuals, the Government has recognized as their representative, and the University Bill now before Parliament gives increased facilities for access to the University by the provision of free places and a students' loan fund. At no time during the last 30 years has the University been able to make adequate provision for the work it has undertaken, and to keep pace with the increasing demands of the subjects it has taught. The main source of its income for general purposes, apart from fees of students, is a Government grant of £21,000, which has not been increased since 1904. The Government now proposes to increase the grant to £30,000; but the increase is accompanied with conditions, some involving loss of revenue, others imposing new obligations, which make the net increase uncertain. The University, like every other institution, is hard hit by the depreciation of money; and must, on that account alone, face a large increase of expenditure. Costly equipment, essential to the carrying on of work, has doubled and trebled in price. A University is a reality, not in virtue of a power to give degrees, but as ensuring certain methods and standards of work, and therefore of life. These must be maintained if the true function and influence of a University is to exist among us. It is altogether a mistake to regard the University merely as the summit of our educational system, whose influence extends only to those who reach it. It is rather the heart of the system, for the soundness and the development of the secondary and technical education throughout the country, and to an increasing degree of the elementary education, depend upon the efficiency of the University. In present conditions—the original meagre provisions, the increased number of students, the decreased value of money—proper University standards cannot be maintained, and essential development is arrested. The last thing to be thought of, whether as a means of reducing the burden carried by the University, or as a means of increasing income, is the raising of students' fees. The Victorian Government is asking the Commonwealth Parliament to increase the State grant. But tradition and policy alike have forbidden a British University to risk its independence by an exclusive reliance upon Government support, and the Victorian Government and the University are in accord in believing that in Victoria, as elsewhere, private citizens will, by their benefactions, co-operate in the maintenance and extension of work which has more than ever a national importance. Our sister University of Sydney has seen its difficulties removed by the McCaughey bequest. We appeal for similar recognition from private citizens. In particular many connected with mining will be specially interested in the new course for a degree in metallurgical engineering, the regulations for which were passed at the last meeting of the council."

BARATTA.—There is still much talk in South Australia and Broken Hill concerning the Baratta silver-lead field, and the richness of the ore that is now being won. Some of the richest ore is from the Baratta Silver-Lead Mining Co.'s properties, the Silver Prince and the Imperial. These samples were sent to Broken Hill on September 17, and assayed as follows: (1) Bulk sample, 36·7% lead, 35·7 oz. silver, 6½ dwt. gold; (2) canary ore, 13·7% lead, 1·6 oz. silver, 1 oz. 5 dwt. gold: (3) iron ore, 3% lead, 1·6 oz. silver, 6½ dwt. gold; (4) wall casing, 37·2% lead, 2·2 oz. silver, trace of gold; (5) open-cut sample, 31·3% lead, 5·5 oz. silver, 19½ dwt. gold; (6) bulk screenings, 21·2% lead, 5·8 oz. silver, 10½ dwt. gold. The canary ore (2) was being discarded as waste, many tons being on the dumps. It is a dirty yellow ore and is being mined in great quantities. Another sample when assayed was found to contain 57% lead, 27 oz. silver, and 16 dwt. gold. One of the residents who has lately visited the major portion of the claims, states that they are all showing rich ore, while others say that before long Baratta will be a second Broken Hill. Owing to heavy rains, there is an ample supply of water for both mining and drinking purposes, sufficient to last at least another twelve months. Many tons of ore are lying at grass ready for transference to Port Pirie, but, owing to the boggy conditions of the roads, it will be some time before a start of the wagons is made.

ALUMINIUM ORES IN WEST AUSTRALIA.—The laterites of West Australia are fairly well known, and they have been described by Mr. E. S. Simpson and by Professor W. G. Woolnough. [See the MAGAZINE for October, 1918, page 221.] Proposals are now in hand for using some of these ores, approximating more closely to bauxite, as sources of aluminium, and Mr. Deschamps, managing director of the Australian Electric Steel Works, has promised to look into the matter. It is understood that workable deposits have been found in the Darling Range, and these are awaiting his inspection.

The presence of hydrated oxides of aluminium, for which the general term "bauxite" is used, in the laterites of Darling Range, has been known for many years. Laterite in sufficient quantity and under suitable conditions, containing 35% or more of aluminium soluble in acids, is regarded at present as a payable ore of aluminium. Before the future of the State as an aluminium producer can be appraised, it will be necessary to undertake the collection and determination of the soluble alumina-content of a large number of laterite samples. A beginning at this work in the Darling Range has been made, following on a request by the Aeroplane Construction Committee of the Commonwealth Department of Defence for bulk samples of bauxitic laterite. Samples were taken with the object of ascertaining, if possible, the conditions which govern the occurrence of commercially valuable bauxitic laterites. To arrive at any degree of finality in such an investigation much more sampling is necessary, but it may be of some assistance to future investigations to describe briefly the appearance and mode of occurrence of the Darling Range laterites, and to show how far the mode of occurrence and general appearance of a laterite may be taken as indications of its value as an ore of aluminium.

The laterites of Darling Range are superficial deposits covering the tops of apparently all the hills of the Range and found for some distance down their flanks, but not, so far as has been observed, in the valleys. They are to be seen almost everywhere on the higher ground outcropping among the fairly thick undergrowth. The laterite is a moderately tough rock bearing a superficial resemblance to iron-stained conglomerate. Examination of freshly broken surfaces, however, shows that the pebbles are nearly all nodules of limonite or other brown iron hydrate having a concentric structure. A few of the pebbles are possibly rounded fragments of a decomposed, ironstained quartzose rock, but microscopic work to settle this point has not been undertaken. The nodules are embedded in a fine-grained matrix varying in colour from dark red to light yellow and containing numerous quartz grains. The general colour of a freshly-broken piece of laterite depends, therefore, on the relative abundance of the reddish-brown pebbles and on the colour of the matrix.

Sections in gravel pits and road cuttings show that the fairly compact deposit here described rarely exceeds 3 ft. in thickness, and does not form an unbroken covering, being, in some places, absent altogether. Underlying it in some places, and in some places altogether replacing it, is a layer of unconsolidated clayey gravel, the pebbles of which are, in the main, limonite nodules like those of the compacted laterite. In some places, however, the hardened cover rests directly on the kaolinized country rock. The gravel layer if present is generally at least 6 ft. thick; beneath it, or if it is absent, directly beneath the cover, a considerable thickness of highly weathered rock must be passed through before the unweathered constituent rocks, the vast majority of which are granitic, are reached. Anyone sampling the laterites will be impressed by their great variability both in appearance and in alumina content. For example, it is not difficult to obtain individual pieces of laterite containing more than 45% of soluble alumina, but the impartially gathered bulk samples so far examined do not rise above 39%. A question of immediate practical importance therefore is whether there are any means by which, without chemical analysis, a laterite rich in bauxite can be recognized.

The specimens yielding the highest percentage of acid-soluble alumina are generally made up of nodules about the size of peas, scattered through a light yellow matrix. The amount of matrix should be at least equal to that of nodules. The freer the matrix is from quartz grains and from pores the better. Laterite that is much ironstained, that is, the matrix of which is covered by reddish-brown limonite rather than by yellow xanthosiderite, is usually of poor grade.

Laterites on the highest ground are probably richer in soluble alumina than are those at lower levels. The character of the underlying rock might be expected to influence the composition of the laterite. At present hardly anything is known regarding the variability in composition of Darling Range granites, so that a large amount of work on these rocks—work which would be hampered by the paucity of outcrops in laterite-bearing localities—would be necessary before anything helpful from this point of view could be deduced. If an air-dried Darling Range laterite shows, on ignition, a loss of 25% or more it will yield in the neighbourhood of 40% acid-soluble alumina, while if its ignition loss be less than 20% its value as an aluminium ore is in grave doubt. If the ignition loss lies between 20 and 25%, its soluble alumina will usually be over 35% and never much less.

It appears that, after a short experience, any workman could distinguish at sight between low and fairly high-grade bauxitic laterites, so that the ore supplied for metallurgical treatment could be maintained at a fairly satisfactory grade by rough hand-picking at the quarry. If this be granted, then it is clear that amounts of payable bauxitic laterite ranging into hundreds of thousands of tons are easily accessible from the railways which traverse Darling Range.

It will be necessary to enlarge the local knowledge of the laterites of the State by much work both in the field and in the laboratory before more definite opinions can be offered regarding their commercial possibilities as ores of aluminium.

VANCOUVER, B.C.

November 1.

OIL STRIKE ON MACKENZIE RIVER.—An important oil strike has been made at Fort Norman, at the junction of the Mackenzie and Great Bear rivers. A minor strike was made last August at this point. The boring was continued and, at the commencement of October, a more prolific oil-sand stratum was struck, which is yielding between 1,000 and 1,500 barrels of oil per day. The oil is of high grade, and has a gravity of about 40° B With reference to this last strike, C. O. Stillman, president of the Imperial Oil Co., which is doing the drilling, has made the following announcement: "We consider this an important oil-strike, and scientifically of much value. From a commercial point of view, however, it is not of immediate value, as it probably will be years before it can be made available for the use of the Canadian market. It will be necessary to determine by actual drilling that there is sufficient quantity of oil to justify the laying of a pipe-line that will cost probably $50,000,000."

Fort Norman occupies a commanding position on the east bank of the Mackenzie river, just east of the junction with the Great Bear river. Geographically its position is 65° north, 126° west of Greenwich. Some idea of the difficulties of the situation from a transport standpoint may be gathered from the following facts. In round figures, Fort Norman is 900 miles from the nearest calling-point of river boats; 1,200 miles from the nearest railroad; and 1,500 miles from the nearest city, Edmonton. At the present time the only means of access is down the northern rivers, which will float only boats of less than 5 ft. draught, and at several points rapids necessitate the unloading and re-loading of the cargoes. During the winter, the intense cold of this northern latitude makes the oil viscous and difficult to handle, and the rivers are frozen so that navigation is impossible for more than three or four months in the year.

A few miles above Fort Norman, on the east side of the river, occasional columns of smoke indicate the presence of fires that are consuming the seams of lignite outcropping along the banks of the Mackenzie. As the coal becomes consumed and spaces are formed, the earth settles, causing landslides, which in places have undermined the banks of the river and caused floods, while the shales in many places along the banks of the river have been reddened by the heat of these underground fires. These fires were first noted by Mackenzie in 1789, so they have been burning for at least 130 years.

The Imperial Oil Co. has staked oil-claims for eight miles on one side of the river and nine miles on the other, the claims covering the numerous islands that are in the river at this point. The river is about three miles wide at Fort Murray.

COAL AND OIL.—The oil situation has become acute, which is likely to have a beneficial influence on the coal-mining industry. Owing to the shortage of oil, the Imperial Oil Company has had to close its refinery, on Burrard Inlet, near Vancouver, and has been unable to renew contracts for distillate. The company has announced that the refinery will be closed until next June, when a supply of Mexican oil that has been arranged for will become available. The s.s. Niagara, which plies between Vancouver and Australian ports, had to fill its tanks at Seattle before making the last trip to Australia. Only recently the boats of this line have been changed from coal to oil burners.

CANADA COPPER CORPORATION.—What should prove to be an epoch-marking milestone in the mining history of this province was passed on October 19, when the Canada Copper Corporation sent its first train-load of ore from its mine at Copper Mountain to its concentrator at Allenby. The placing of the property on a shipping basis has been a prodigious undertaking fraught with heart-breaking difficulties in the way of strikes, which have retarded the commencement of operations fully nine months and added about 10% to the cost. The opening of the property entailed the construction of 12 miles of railway through a difficult mountainous country, the construction of a long high-power electric transmission line, as well as the erection of the mill and development of the mine. The whole thing has involved the expenditure of $7,000,000 before any returns have been made.

The mine is situated about 12 miles from Princeton and the mill four miles nearer to that town. An ore reserve of 12,000,000 tons has been proved at the mine, the copper content of the ore running a little better than 2%. The initial capacity of the mill is 2,000 tons daily, and provision has been made for readily doubling this capacity. At the present time the company is employing 300 men at mine and mill, but this number will be increased to 500 as men can be secured. It is expected that by the end of the year this number of men will be on the pay-roll, and that the mill will be running at full capacity. Preliminary experiments have demonstrated that a concentrate containing 25% of copper can be made. This will be shipped to the Trail smelter. With a view to treating this concentrate, the Consolidated Mining & Smelting Co. has erected three sintering furnaces, enlarged its copper-smelting and anode-casting plant, and increased the capacity of its electrolytic refinery to 50 tons of refined copper per day. The company has started the erection of a copper-rod mill, so that the finished product may be sold in Canada. Up to now all the copper rods for wire-drawing for the extensive telephone and telegraph systems throughout Canada have been made in the United States.

PREMIER MINE.—H. A. Guess, mining engineer for the American Smelting & Refining Company, paid a visit to the Premier mine in the early part of November. The Guggenheim interests, which control the A. S. & R. Co., own a two-fifths interest and have an option on another fifth of the Premier mine. Mr. Guess expressed himself as being thoroughly satisfied at the way the mine was developing, and said it had quite come up to expectations. Owing to the rains in the summer washing out the roads, the erection of the concentration and cyanide plants has been delayed, and they will not be in operation until next spring. During the winter months work will be confined to getting out ore and shipping it to the smelter. Two new snow-tractors are on their way to Stewart, and these will be used in hauling ore from the mine to Stewart. Between 50 and 60 horses also will be employed in this work. It is expected that not less than 3,000 tons of high-grade ore, running between \$275 and \$300 per ton, will be shipped during the winter. The winning of this will give a large tonnage of milling ore, which will be treated in the new plant next year. The machinery for the new plant is on the wharf at Stewart, and will be hauled to the mine by the returning ore-waggons. The new water-power plant has been completed.

TORONTO.

November 12.

PORCUPINE. — Labour conditions, which have been unsatisfactory for some time, have latterly considerably improved. Early in the season many men employed in the mines threw up their jobs to obtain work in the United States at high wages. Now that industrial depression has set in, there has been an influx of unemployed men from across the border, which has considerably relieved the situation in the Northern Ontario mining camps. The Dome Mines has also increased its working forces by bringing over 109 Cornish miners under a four-months contract. Another difficulty with which mine operators have had to contend was power shortage owing to protracted drought, but this is being overcome by reason of recent heavy rainfalls, and everything points to a considerable increase in the output.

A financial statement issued by the Dome Mines, covering the five months ended August 31, shows gross earnings of \$855,188, and net profits of \$198,467, or at the rate of nearly 12%, after writing off \$307,316 for depletion, depreciation, and income tax.

The McIntyre is maintaining its output at a rate well over \$2,000,000 a year and adding largely to its ore reserves by development on the lower levels. The opening up of a large ore-body below the 1,000 ft. level and paralleling the No. 5 vein is regarded as one of the most important developments of the camp in recent years, as this deposit is conceded to be a continuation of vein No. 84 on the Hollinger Consolidated, which is estimated to contain an ore reserve of \$6,282,620 so far as opened up on that mine. This amount is chiefly above the 800 ft. level, and should it continue to such depth as has now been shown on the McIntyre the ore reserves of the Hollinger will be largely increased by deeper mining. Up to the present the Hollinger has developed 38 veins and has 39 veins outcropping on the surface which have not been worked, and it has not been found necessary to carry sinking operations to any great depth as yet.

The financial statement presented at the annual meeting of the North Davidson showed an expenditure of \$73,256 up to September 30. President R. T. Jeffrey reported that results from development and exploration had been highly gratifying, assays from three drill-holes averaging about \$25 to the ton. A rich vein 4 ft. wide had been cut at a depth of 52 ft. in the shaft.

Ore in sight on the Porcupine Vipond-North Thompson is estimated at about 130,000 tons, of the approximate value of \$1,250,000. The company plans the sinking of the shaft from its present depth of 600 ft. to the 900 or 1,000 ft. level, and the extension and remodelling of the mill to increase its capacity to 150 tons daily.

KIRKLAND LAKE.—The Lake Shore during September produced \$40,150 from the treatment of 1,480 tons of ore, being an average yield of \$27·12 per ton. The total production for the first nine months of the year amounted to \$372,646. The Kirkland Lake has encountered good ore at the 900 ft. level, where about 125 ft. of driving has been accomplished. Ore carrying free gold and tellurides over a width of 5 ft. yielded assays across the face averaging \$52. This development proves an ore-body extending downward for 700 ft. from the 200 ft. level. The mill is treating 110 tons of ore per day. The Kirkland Lake Proprietary (1919), Ltd., has completed the taking over of the assets of the English Tough Oakes Gold Mines, the old Kirkland Lake Proprietary, the English Aladdin-Cobalt, and the Sudbury Syndicate. It is negotiating for the acquisition of the assets of the Ontario Tough-Oakes, the Burnside, and the Sylvanite companies. The Hunton-Kirkland has increased its capital from \$1,500,000 to \$2,500,000. The shaft, which is being put down to the 400 ft. level, encountered a wide vein which dipped out of the shaft at a depth of 60 ft. The Ontario-Kirkland has decided to delay the work on its mill until spring in the expectation that material will then be cheaper and labour more plentiful. At the Bidgood a wide vein has been tapped in driving on the 300 ft. level. An ore-body on the 425 ft. level of the Orr property, formerly the Kirkland Porphyry, has been shown to extend for at least 400 ft., with an average width of 10 ft. giving good assay-values.

COBALT.—The mine operators are now paying a flat wage to their employees in place of supplementing the base wages with a bonus regulated by the price of silver. The new plan increases the pay to a figure equal to the former wage, plus the bonus given when silver was selling high. This secures the men against reductions due to market fluctuations and attracts additional labour to this field. The increase in the price of cobalt metal, now valued at about $4 per lb., has drawn attention to properties on which smaltite veins occur, several of which have been sold or taken over on option. The value of the cobalt by-product is becoming a more important factor in the returns of producing mines. The Kerr Lake has completed the construction of a crusher for the handling of low-grade ore before its shipment for treatment to the Dominion Reduction mill. Three new veins encountered in digging the foundation of the crusher have been proved to be important and will be developed on the 90 and 150 ft. levels. The La Rose is taking high-grade ore from its University property and has considerably increased its working forces. The Mining Corporation is making good progress with the development of its Buffalo property, on which a large surface vein is being developed by open-cut for some 200 ft. The Bailey appears for the first time on the list of shippers, having sent out a car of 87,116 lb. of ore. At the Lumsden, operated by the Camburn Co., a high-grade vein 8 in. wide is being opened up at the 225 ft. level. High-grade ore has also been found on the 300 ft. level. The Ruby Silver at North Cobalt is developing a strong calcite vein, sections of which carry high-grade ore running about 1,000 oz. to the ton. The Nipissing during October mined ore of an estimated value of $184,578, and shipped bullion and residue from Nipissing and custom ores of an estimated net value of $316,475.

FLIN - FLON COPPER. — The syndicate headed by Col. W. B. Thompson, of New York, which includes the Mining Corporation of Canada, has made excellent progress in the work of testing the Flin-Flon copper deposit in Northern Manitoba, their option on which expires on March 1. The originally planned expenditure of $200,000 has, it is stated, been considerably exceeded. Two shafts have been put down, each 200 ft., and extensive lateral work has been accomplished, as a result of which the ore-body is now estimated at 24,000,000 tons instead of the former estimate of 20,000,000. Work will be continued through the winter, and the shafts put down an additional 100 ft. The Provincial Government is favourably considering the construction of a railway to tap the Flin-Flon area, in case the syndicate decides to exercise its option, and in the meantime the route is being surveyed and an estimate of the cost of construction prepared, to be laid before the Manitoba Legislature. Should the syndicate take up the option, the price to be paid for the property is $1,000,000.

PERSONAL

JOHN A. BEVAN is back from Spitsbergen.

W. BROWN has left for Penang.

ARTHUR J. CADDICK has returned to Spain.

J. M. CAIRNS has left for Spain.

G. W. CAMPION is here from West Africa.

J. E. CLENNELL is engaged in researches into corrosion problems at the Royal School of Mines.

C. F. COURTNEY is here from Broken Hill.

R. COUSIN has resigned as general manager of the Kwall Tin Fields of Nigeria, Ltd.

A. B. COUSSMAKER has left for Australia.

G. ALLEN CRANE has opened an office at Vancouver.

T. F. G. DEXTER has been awarded the Henwood gold medal of the Royal Institution of Cornwall.

ARTHUR DICKINSON and R. H. CONRAN have left for Brazil for the purpose of inspecting gold mines in the State of Goyaz.

FRANCIS DRAKE has returned from Australia.

EDGAR L. EDMONDS is expected from Nigeria.

W. R. FELDTMANN is back from West Africa.

J. G. FLYNN has been appointed superintendent of the El Oro company's mines.

A. G. GLENISTER left on November 27 on his return to the Federated Malay States.

WALTER GOODFELLOW has gone to Brazil for Bainbridge, Seymour & Co., Ltd.

L. C. GRATON has gone from the United States to Peru.

R. T. HANCOCK left for Colombia, where he is taking a position with the Nechi Consolidated Gold Mining Co., Ltd.

H. B. HAUSER has been appointed lecturer in geology in Perth University.

E. L. HAWES is going to Johannesburg for the Ingersoll-Rand Company.

HYMAN HERMAN has resigned as director of the Geological Survey of Victoria to take charge of the research work in connection with the utilization of the Morwell brown coal deposits.

T. J. HOOVER has moved his office from Mills Building to the Balfour Building, San Francisco.

H. H. JOHNSON has reopened his London office at 4-6 Copthall Avenue, and has gone to Burma for the Indo-Burma Oilfields (1920) Ltd.

P. K. LUCKE is here from Mexico.

R. R. MABSON is about to visit the Rand on behalf of the *Stock Exchange Gazette*.

SIR DOUGLAS MAWSON has been appointed professor of geology and mineralogy in the University of Adelaide.

J. H. MEIKLEJOHN, lately with the Broughton Copper Co., has been appointed engineer to the Austral Bronze Co., Sydney.

ROBERT MOND is visiting Canada.

A. W. NEWBERRY sailed from New York for Central America on November 27, and expects to be away for three months.

C. T. NICOLSON has left for the United States.

SIR LIONEL PHILLIPS has left for South Africa.

E. B. RIDSDEL has returned from South Africa.

JAMES ROBERTS is here from Nigeria.

ARTHUR SAXTON is here from West Africa.

PROFESSOR E. W. SKEATS is here from Melbourne.

F. F. SKURRAY has returned from Nigeria.

J. E. SNELUS is returning to Nigeria.

HENRY STRAKOSCH, managing director in London of the Union Corporation, has been elected a member of the financial and economic committee formed by the Council of the League of Nations.

E. HOGAN TAYLOR, late of Great Cobar, has been appointed manager of the New Guinea Copper Mines Co.'s properties in Papua.

DAVID THOMAS is expected from Nigeria.

H. W. TURNER has moved his office from Mills Building to the Balfour Building, San Francisco.

G. D. VAN ARSDALE has opened an office at Los Angeles, California, as consulting engineer in hydrometallurgy and flotation.

A. B. WATSON is back from West Africa.

C. M. WELD, mining engineer, D. M. LIDDELL, chemical engineer and metallurgist, and P. H. LAZENBY, civil engineer with experience in public utilities, have formed a partnership as Weld, Liddell, & Lazenby, with offices at 2, Rector Street, New York.

P. C. WHITEHEAD left last month for Nigeria, to take over the management of the Dua.

JAMES WICKETT entered his 80th year on November 23. Everybody will wish this energetic supporter of Cornish and Malayan tin mining many more years of useful life.

DAVID A. HERRON, manager of the Tomboy Company's gold mines in Colorado, died on September 24.

T. DUNDAS PILLANS, secretary of the El Oro, Tomboy, and other companies of the Exploration Company group, died on November 15.

EDWARD HALL WATSON died of fever last month in Burma, where he had only arrived a short time previously. He was well known for his alluvial mining work previously done in Siberia.

LORD GLENCONNER died on November 21 at the age of 61. He was the eldest son of the late Sir Charles Tennant, and succeeded him as chief proprietor of the celebrated chemical works at Glasgow, and as chairman of several of the Indian gold-mining companies and the Tharsis Sulphur & Copper Company.

THE EARL OF BESSBOROUGH died suddenly on December 1, in his 70th year. In mining circles he was well known as the chairman of the Ashanti Goldfields Corporation, but his business activities were of a very wide range. He was chairman of the London, Brighton, & South Coast Railway, Guest, Keen, & Nettlefolds, the Gordon Hotels, and Apollinaris & Johannis, and he was a director of the Imperial Ottoman Bank and the Bank of Roumania.

THOMAS NEGUS died at Camborne last month at the age of 81. He was a Cornishman by birth, and went to Mexico to engage in mining over fifty years ago. On his return he became surveyor to Camborne Local Board and Urban Council. Of recent years he conducted a stockbroker's business in Camborne. He had a large holding in Grenville, and was chairman of the company until recently. His son, James Negus, is mine superintendent at Mount Boppy, New South Wales.

JAMES HART FAWCETT died of heart failure on November 20 at Miranda de Ebro, Spain, where he was engaged in making an examination of a group of mines for an English company. Mr. Fawcett was born in Cumberland, but went with his parents as a child to Australia. He was at Broken Hill in the early days, and was the first assayer there in 1883. He pegged out claims, and one of the blows in that property was known by his name. From 1892 to 1894 he was in London in charge of the metallurgical work of the Broken Hill Proprietary. Subsequently, he conducted investigation and exploration in West Australia for a London firm of metal brokers. He was general manager for the Etruscan Copper Co., operating in Italy, and extracted and smelted most of the ore that was in the mine belonging to that unfortunate enterprise. Afterwards he was one of Bewick-Moreing's engineers in Melbourne. Of late years he conducted a general consulting practice, visiting many mines in Australia and elsewhere. He recently made a study of diamond mining in South Africa. He returned to this country last May. His first wife was a sister of William Jamieson, the earliest manager and now a director of the Broken Hill Proprietary.

SIDNEY RICKMAN ADAMS died suddenly on November 2, at Abadan, Persia, where he was engaged in erecting a large plant for the Anglo-Persian Oil Company on behalf of the Ridge Roasting Furnace & Engineering Company. After being for five years at Palmer's Shipbuilding and Iron Co., Ltd., and for three years with the London & South Western Railway, he went to South Africa in 1893. In the following year he was in charge of the construction of the plant and mill extension of the Langlaagte, and then joined the head office engineering staff of the Consolidated Gold Fields, being employed on the design of the plant of the various mines belonging to that group. He was resident construction engineer on the Simmer & Jack and Nigel Deep. He was responsible for the new plants on the Cinderella Deep, West Rand Mines, Aurora West, Meyer & Charlton, and George Goch. The equipment of Tweefontein Colliery was carried out by him. For the Oceana Consolidated he equipped the Rooiberg tin mines in the Transvaal and went out to the Taquah and Abosso mines in West Africa. Being over age, he experienced difficulty in joining up after the outbreak of war, but he quickly obtained promotion and went to Gallipoli in the Royal Naval Division with the rank of Major. Later he was sent to France with the Royal Engineers, and suffered there at one of the gas attacks. After demobilization he joined the staff of the Ridge Roasting & Engineering Company, and went to Persia. He was a member of the Institution of Mechanical Engineers.

ARTHUR STRAUSS, of A. Strauss & Co., tin dealers and merchants of Rood Lane, London, E.C., died on November 30. By his death the London Metal Exchange loses one of its oldest members, and one who for many years was probably by far its most prominent and forceful personality. Shrewd and resourceful to a degree, he planned and carried out many very successful campaigns in tin, mostly on the bear tack, but unlike most market operators he invariably played a lone hand. He had no market confidants or allies. His deals were carried out by himself, not by the aid of brokers or other intermediaries; and while he expected no business favours, so he granted none. With him business was always business, but when commercialism played no part, there was nevertheless a softer side to his nature. Of German origin and born in Hesse, he started business in London with his brother, the late Alphonse Strauss, in the early 'seventies. Their ambition to be the leading firm in the tin trade was realized, and for years they were predominant, their offices proving moreover to be the nursery for a number of lesser lights in the tin world, some now dead, others still very much alive. The brothers made an excellent combination, and it is no secret that Arthur Strauss greatly missed the able assistance of his brother, whose financial ability was of the highest order. On the death of Alphonse the firm of A. Strauss & Co. became by degrees less and less prominent, probably to some extent because the surviving partner was content to rest on his laurels, and to take life more easily. He never entered the London Metal Exchange after the official request was made that members of German birth should refrain from attending the market, and the war itself naturally limited the activities of firms dealing in metals. He was largely interested in the Penpoll tin smelting works at Devoran and Liverpool. For some years he represented Camborne and North Paddington in Parliament, which latter constituency he contested unsuccessfully at the last general election. He vigorously opposed the Non-Ferrous Metals Bill, the inception and real bearings of which, and their significance, he appreciated to a nicety. While excluded from the Metal Exchange by the anti-German resolution, Mr. Strauss sustained a great loss through the death in the war of his eldest son, an officer in the R.A.F. His own end came swiftly. He was in business on November 30, and left it apparently in his usual health, but died from a heart attack soon after reaching home. He was 73 years old. His surviving son recently entered the business of the firm, which is being carried on by the remaining partner.

TRADE PARAGRAPHS

The Super-Vice Engineering Co., Ltd., have moved their office from the Hop Exchange to 190, Bishopsgate, London, E.C.2.

The Cement Gun Co., of Allentown, Pennsylvania, send us a pamphlet giving the results of official tests of the strength of "Gunite" slabs.

The "Edgar Allen News" for November contains an article on the steel casting practice at the works of Edgar Allen & Co., Ltd., Imperial Steel Works, Sheffield.

Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester, send us a pamphlet relating to their Rateau reducing-pressure steam turbine, and a number of pamphlets relating to condensing plant.

The British Electric Vehicles, Ltd., of Southport, make a specialty of electric locomotives for mines, driven by accumulators. They have recently received orders for their locomotives from the New Zealand Government.

J. H. Sankey & Son, Ltd., of Essex Wharf, Canning Town, London, E., makers of firebricks, fire cements, and refractories, have issued a chart giving the chief metallurgical temperatures and a diagram showing the colour at the various temperatures.

The Allis-Chalmers Manufacturing Co., of Milwaukee (London Office, Salisbury House), send us a number of recent catalogues, dealing with ball granulators, that is, ball-mills suitable for producing granular material; rotary kilns, coolers, and driers; concentration machinery and equipment; and cyanide plants and equipment.

The Nordberg Manufacturing Co., of Milwaukee, U.S.A., have extended their works in order to keep pace with their increase in business. They make a specialty of 2,000 h.p. Diesel engines and winding engines. They are making a winding engine for the Mitsui mines in Japan, which it is believed will be the largest ever exported from the United States.

Explosives Trades, Ltd., of 6, Cavendish Square, London, W.1, have changed their name to Nobel Industries, Ltd. The company is engaged in the manufacture of other articles than explosives; in fact explosives account for only 40% of the total business. The name of Nobel is a valuable asset in itself, and it was felt that it should be introduced into the title of the company.

The Hardinge Company, of New York, and 551, Salisbury House, London, E.C.2, send us a number of new pamphlets as follow: Ball-Mill Data, giving comparisons with grated cylindrical ball-mills; Grinding Data, giving results of the Hardinge mill at various installations; and Grinding Shale for Dusting Coal Mines. The company is about to move its London office to larger premises at 11–13, Southampton Row, W.C.1.

The New York Engineering Co., of 2, Rector Street, New York, are putting on the market a new

The Ludlum Dynamobile.

mobile power unit called the "Ludlum Dynamobile," which is intended for driving the small portable conveyors used in certain classes of mining in South Africa. Previously, power for this purpose was furnished by the old-fashioned reciprocating engine and portable boiler, with belt and pulley transmission to the conveyor. The object of the Ludlum Dynamobile is to realize the utmost economy in generating power, and high economy and great flexibility in delivering that power to the driven mechanism. The Dynamobile consists of a special type of Ludlum water-tube marine boiler, a steam turbo-generator unit, switchboard, boiler feed pump, feed-water heater, condenser and, where the highest economy is sought, a superheater, all mounted on a steel frame carried on wheels. It is extremely simple in construction and in operation, is free from vibration, and is practically fool-proof in construction. The Ludlum marine boiler has gained wide acceptance in the marine world by virtue of its high economy, simplicity, and compactness. In the Dynamobile illustrated, the boiler was designed for burning wood, the combustion chamber being unsually large. But the outfit can be furnished for burning any kind of fuel. The combustion chamber is entirely surrounded by the water-filled steam-generating parts of the boiler, this not only assuring high economy but also doing away with all fire-brick lining. The latter feature is of special value in a portable plant like this, as transportation over rough roads would break or dislodge a fire-brick furnace lining. The high efficiency of the boiler and turbo-generator set, and its compactness and light weight, makes the Dynamobile a most economical and desirable unit for portable power purposes, as it can be located near its source of fuel and its power electrically transmitted to any reasonable distance with minimum loss. This new high-duty portable plant will be a serious rival to the European outfits known as Locomobiles and extensively used in foreign countries. The latter consists of an internally-fired boiler of high efficiency with a reciprocating steam engine, and contains many refinements making for economy, and in spite of the fact that it is very heavy and costly, the Locomobile has found extensive use abroad because of its economy. The weight of the Ludlum Dynamobile is only about one-third that of the Locomobile and its price is much lower, while its efficiency is claimed to be even higher than that of the European unit. The outfit illustrated is of 10 k.w. capacity. Larger units up to 200 k.w. are furnished, either alternating or direct current.

METAL MARKETS

COPPER.—The month of November witnessed a general decline in copper values. The weakness was once more traceable to the United States, where the big producers, in spite of the reductions already made in prices, have as yet been unable to dispose of a sufficiently large proportion of their big surplus stock of metal. The burden of financing the accumulations has made it necessary for producers to make cuts in their price in the hopes of stimulating business. So far, however, they have been rather too slow in shading their prices, and the reductions in quotations were generally already anticipated by dealers. The result is that although the price in America touched below 13½ cents per lb. it seems very doubtful if any important quantity has been moved. In the meanwhile, consumers here have had the advantage of buying at fairly low figures, as electrolytic copper in this country has been frequently sold at lower prices than the actual importing cost. While this may have been to a certain extent intelligent anticipation on the part of dealers as to the course of the market in America, it may also have been induced by expectations of an improving dollar exchange, which, of course, would reduce the parity here. The standard market reflected the easier conditions in electrolytic, the general financial unsettlement, and the unsatisfactory Wall Street reports which have come to hand from New York. Prices were marked down considerably during the month. Meanwhile business in copper with the consuming trades in this country has been restricted, buyers confining their purchases to early deliveries, and apparently following a hand-to-mouth policy. It is generally believed that consumers are not well bought, and a change in sentiment might bring out a fair amount of business which would help the reaction. It seems probable, however, that consumers' order books are not so well filled as they were at one time, and they may not have so much business to cover as is supposed. The whole sentiment of the market might change very quickly, but the generally pessimistic feeling which has ruled recently in regard to all markets has not been conducive to much change in an upward direction. As regards manufactured copper, inquiry has been very quiet, India, of course, being still out of the market.

Average prices of cash standard copper: November 1920, £84. 18s. 6d.; October 1920, £93. 10s. 1d.; November 1919, £98. 18s. 9d.; October 1919, £103. 10s. 11d.

TIN.—The market during November fluctuated somewhat, but with a generally flat tendency, the drop on the month amounting to about £60 per ton. For some time previously the situation in tin had been regarded as fairly good, and a substantial rise in prices appeared to be generally anticipated. However, recent circumstances in the financial world, and in the markets for all commodities, have been distinctly against a rise in the price of anything, and during the period under review prices came below figures which had been touched in pre-war days. In spite of that fact, however, the market is still at a fairly high price as compared to what was formerly regarded as a normal level before the war. Of course, one of the chief factors against this market has been the failure of the demand from the United States. Conditions there seem to have been very unsatisfactory, and although it is understood that the tinplate trade in the United States has been fairly active, and that the stocks held by users must be getting worked down, still there has been sufficient metal on the spot in America to meet any immediate demand, and any slight improvement in the inquiry there was really not felt materially here. Meanwhile consumers in this country have been following a hand-to-mouth policy in regard to their purchases. The tinplate market in this country has not been in a satisfactory condition, business being slow, and prices unremunerative, so that there has been a tendency to slow-down operations, the reduction in the number of mills operating during October in Wales amounting to 46. In regard to supplies, there are certainly fair stocks in this country, and as the Straits have been selling rather sparingly it looks as if some accumulations might have collected there. There are probably some stocks in Batavia, but it is thought that those in China have been reduced, although there may still be a moderate quantity in that quarter. Of this it is believed a fair proportion is No. 3 grade, which is not so much in demand in this country. In addition to these, there is also understood to be a fair stock of tin in Holland. All things considered, therefore, for the moment there seems to be plenty of tin in sight, while the demand is distinctly slack. Early in December it became known that an arrangement had been come to in the East whereby the Government of the Straits Settlements would take over from the smelters from day to day any unsold quantities of tin at a price which

Daily London Metal Prices: Official Closing
Copper, Lead, Zinc, and Tin per Long

	Copper				
	Standard Cash	Standard (3 mos.)	Electrolytic	Wire-Bars	Best Selected
	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
Nov. 10	90 0 0 to 90 5 0	88 15 0 to 89 0 0	100 0 0 to 102 0 0	100 0 0 to 102 0 0	99 0 0 to 100 0 0
11	87 17 6 to 88 0 0	87 0 0 to 87 5 0	99 0 0 to 101 0 0	99 0 0 to 101 0 0	99 0 0 to 100 0 0
12	87 5 0 to 87 10 0	86 15 0 to 87 0 0	99 0 0 to 101 0 0	99 0 0 to 101 0 0	98 0 0 to 99 0 0
15	85 15 0 to 86 0 0	84 10 0 to 84 15 0	96 0 0 to 98 0 0	96 0 0 to 98 0 0	98 0 0 to 99 0 0
16	84 15 0 to 85 0 0	83 15 0 to 84 0 0	95 10 0 to 97 10 0	95 10 0 to 97 10 0	94 0 0 to 96 0 0
17	84 0 0 to 84 5 0	83 15 0 to 84 0 0	95 0 0 to 97 0 0	95 0 0 to 97 0 0	94 0 0 to 96 0 0
18	83 2 6 to 83 7 6	83 2 6 to 83 7 6	94 0 0 to 96 0 0	94 0 0 to 96 0 0	94 0 0 to 96 0 0
19	81 5 0 to 81 10 0	81 5 0 to 81 10 0	93 0 0 to 95 0 0	93 0 0 to 95 0 0	92 0 0 to 93 0 0
22	78 10 0 to 78 15 0	79 0 0 to 79 5 0	90 0 0 to 92 0 0	90 0 0 to 92 0 0	92 0 0 to 93 0 0
23	78 10 0 to 78 15 0	79 0 0 to 79 5 0	90 0 0 to 92 0 0	90 0 0 to 92 0 0	88 0 0 to 90 0 0
24	78 10 0 to 78 15 0	79 0 0 to 79 5 0	90 0 0 to 91 10 0	90 0 0 to 91 10 0	88 0 0 to 90 0 0
25	78 5 0 to 78 10 0	79 0 0 to 79 5 0	90 0 0 to 91 10 0	90 0 0 to 91 10 0	88 0 0 to 90 0 0
26	78 0 0 to 78 5 0	78 5 0 to 78 10 0	90 0 0 to 91 0 0	90 0 0 to 91 0 0	86 0 0 to 88 0 0
29	77 5 0 to 77 10 0	77 15 0 to 78 0 0	87 0 0 to 89 0 0	87 0 0 to 89 0 0	86 0 0 to 88 0 0
30	75 5 0 to 75 10 0	75 15 0 to 76 0 0	84 0 0 to 85 0 0	84 0 0 to 85 0 0	81 0 0 to 83 0 0
Dec. 1	76 15 0 to 77 0 0	77 5 0 to 77 10 0	85 0 0 to 86 0 0	85 0 0 to 86 0 0	81 0 0 to 83 0 0
2	78 10 0 to 78 15 0	78 15 0 to 79 0 0	88 0 0 to 89 0 0	88 0 0 to 89 0 0	81 0 0 to 83 0 0
3	79 15 0 to 80 0 0	80 0 0 to 80 5 0	88 10 0 to 89 10 0	88 10 0 to 89 10 0	86 10 0 to 87 10 0
6	79 15 0 to 80 0 0	79 10 6 to 79 15 0	90 0 0 to 90 10 0	90 0 0 to 90 10 0	86 10 0 to 87 10 0
7	80 10 0 to 80 15 0	80 0 0 to 80 5 0	90 10 0 to 91 0 0	90 10 0 to 91 0 0	88 0 0 to 89 0 0
8	81 10 0 to 81 15 0	81 5 0 to 81 10 0	91 0 0 to 92 0 0	91 0 0 to 92 0 0	88 0 0 to 89 0 0
9	79 15 0 to 80 0 0	79 7 6 to 79 12 6	90 0 0 to 91 0 0	90 10 0 to 91 0 0	88 0 0 to 88 0 0

would equal about £226 to £227 landed here. As this tended to stabilize the market in the Straits and to prevent any decline, the news had a firming effect on values in London.

Average prices of cash standard tin: November 1920, £241. 5s. 6d.; October 1920, £258. 8s. 8d.; November 1919, £283. 13s. 7d.; October 1919, £279. 4s. 10d.

Lead.—Like others, this metal also declined during the month of November, and while this may be partly due to sympathy with other markets, the fact remains that considerably more selling appeared, not only for forward, but also for early lead. In view of the comparative tightness of the near position, free offerings of November lead came as somewhat of a surprise. Hitherto the near position had stood at a premium compared to forward, but the position was quickly reversed. About the middle of the month advices reached London from the Broken Hill Company in Melbourne to the effect that they expected to resume production in January and to commence shipments in February. The total monthly production it was expected would amount to 7,000 tons, of which quantity 4,500 to 5,000 tons would be available for export to Europe and America. It was also stated that the Associated Smelters' stocks of pig lead were nil, and that there were no Government stocks in Australia. It had previously been announced that the strike has been declared off on November 10, and this further news did much to clear up the doubts in regard to the position in that quarter. It cannot be said that the announcement had any very definite effect on the market, although in some quarters it is believed that the forward sellings indulged in were bear operations, based on the prospect of more liberal supplies coming from Australia. To put the decline down to any particular feature, however, is rather difficult, as the whole tendency of the metal markets was in any case toward a lower level. In the meanwhile, business with consumers has been fairly steady, but not particularly large, and in the bulk of cases, buyers confined their purchase to early deliveries. A little inquiry has come to hand from Japan, and some business has been done, but so far it has not amounted to anything very important. The market in America has shown rather a weak tone, and the price of the chief interest there dropped to 5½ cents. In many quarters it is believed that before very long the position may be such that offerings of metal will come from America.

Average prices of soft pig lead: November 1920, £32. 5s. 6d.; October 1920, £35. 2s. 1d.; November 1919, £34. 16s.; October 1919, £28. 15s. 11d.

Spelter.—This market has not made a very good showing during the past month, and this must be largely attributed to the lack of any good consuming demand, coupled with the inducement offered by the adverse exchange rates for Continental countries to offer their metal here. Early in the month Germany came out with some offers, and this was instrumental in bringing about a weaker tone on the market. On the top of this, Belgium, which country had previously been withholding from the market owing to the unprofitable level of prices, also came out with offers owing to the decline in the Belgian exchange. These factors naturally had a depressing effect on prices here, especially when there was an insufficient consuming demand to take care of the spelter. Latterly, however, there was less desire on the part of the Continent to sell. What is the uncertain factor is the stock of spelter in Norway, which for a long time has been held for prices which are rather above the market here. Holders no doubt could have disposed of the metal at much better prices than are now obtainable, and it may be that, seeing they missed their chance, they will hold on in hopes of getting a better price ultimately. What, however, must be recollected is that the financing of this metal must be somewhat burdensome, and may be the means of forcing it out. Apart from this Norwegian position, the market seems to be in a fairly sound condition, as there seems to be no prospect of America offering here at prices which would make business possible. Indeed early in December some buying was done here by the United States, which had a firming effect on prices. The galvanized sheet business has been very quiet for some time, and therefore the consumption of spelter in this country has been distinctly restricted, and however sound the position might be, it would appear to be necessary that a revival in general trade should take place before any permanent rise could be seen in this market.

Average prices of spelter: November 1920, £35.

Prices on the London Metal Exchange.
Tons; Silver per Standard Ounce; Gold per Fine Ounce.

Lead: Soft Foreign	Lead: English	Zinc (Spelter)	Standard Tin: Cash	Standard Tin: 3 mos.	Silver: Cash	Silver: Forward	Gold	
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.			s. d.	Nov.
35 10 0 to 34 10 0	37 0 0	36 15 0 to 38 0 0	242 10 0 to 242 15 0	247 0 0 to 247 5 0	$54\frac{5}{8}$	$54\frac{3}{8}$	121 0	10
34 15 0 to 33 17 6	36 5 0	36 0 0 to 37 5 0	244 0 0 to 244 10 0	249 0 0 to 249 10 0	$54\frac{1}{8}$	$53\frac{7}{8}$	121 4	11
34 10 0 to 33 10 0	36 0 0	36 0 0 to 37 7 6	244 15 0 to 245 5 0	249 15 0 to 250 0 0	$53\frac{7}{8}$	$53\frac{1}{2}$	121 11	12
34 10 0 to 32 10 0	36 0 0	34 15 0 to 36 5 0	236 15 0 to 237 5 0	242 10 0 to 243 0 0	$51\frac{3}{8}$	51	121 6	15
33 10 0 to 31 15 0	35 0 0	34 15 0 to 36 2 6	239 0 0 to 239 10 0	242 10 0 to 243 0 0	51	$50\frac{1}{2}$	120 9	16
32 0 0 to 31 12 6	33 10 0	35 0 0 to 36 12 6	242 15 0 to 243 0 0	246 0 0 to 246 5 0	$51\frac{3}{8}$	$51\frac{1}{8}$	118 9	17
32 15 0 to 32 5 0	34 0 0	35 2 6 to 36 12 6	246 5 0 to 246 10 0	249 17 6 to 250 2 6	$50\frac{3}{4}$	$50\frac{1}{2}$	117 2	18
32 10 0 to 31 15 0	33 10 0	34 5 0 to 35 10 0	239 10 0 to 240 0 0	243 15 0 to 244 0 0	$49\frac{7}{8}$	$49\frac{7}{8}$	118 4	19
30 15 0 to 29 15 0	32 0 0	33 10 0 to 34 17 6	231 0 0 to 231 10 0	234 0 0 to 234 10 0	$47\frac{3}{4}$	48	117 0	22
29 0 0 to 29 0 0	31 0 0	33 10 0 to 34 17 6	230 15 0 to 231 0 0	234 15 0 to 235 0 0	$47\frac{1}{8}$	$47\frac{1}{4}$	115 10	23
28 5 0 to 29 0 0	30 0 0	33 7 6 to 34 15 0	231 0 0 to 231 5 0	235 0 0 to 235 5 0	$46\frac{1}{4}$	$46\frac{3}{8}$	117 0	24
28 5 0 to 29 5 0	30 0 0	32 15 0 to 34 5 0	229 5 0 to 229 10 0	232 15 0 to 233 0 0	$47\frac{1}{4}$	$47\frac{3}{8}$	117 7	25
28 0 0 to 28 17 6	30 0 0	32 5 0 to 33 5 0	221 5 0 to 221 10 0	225 0 0 to 225 5 0	$48\frac{3}{4}$	$48\frac{1}{2}$	117 7	26
25 10 0 to 25 15 0	27 0 0	29 10 0 to 31 0 0	208 15 0 to 209 0 0	212 10 0 to 213 0 0	$46\frac{1}{8}$	$46\frac{1}{8}$	117 1	29
25 0 0 to 26 0 0	27 0 0	29 7 6 to 31 5 0	207 10 0 to 208 0 0	212 0 0 to 212 10 0	$43\frac{7}{8}$	$44\frac{1}{8}$	117 6	30
								Dec.
26 5 0 to 27 0 0	28 0 0	29 15 0 to 31 10 0	208 15 0 to 209 5 0	213 15 0 to 214 5 0	$44\frac{5}{8}$	$44\frac{3}{4}$	117 5	1
28 15 0 to 29 10 0	30 10 0	30 10 0 to 32 5 0	214 0 0 to 214 10 0	219 0 0 to 219 10 0	$44\frac{3}{8}$	$44\frac{5}{8}$	117 4	2
27 5 0 to 28 0 0	29 0 0	31 10 0 to 33 5 0	221 0 0 to 221 10 0	224 10 0 to 225 0 0	$44\frac{3}{4}$	45	117 6	3
26 10 0 to 27 5 0	28 10 0	30 15 0 to 32 10 0	218 10 0 to 219 0 0	222 10 0 to 222 15 0	$43\frac{7}{8}$	$44\frac{1}{8}$	118 2	6
26 0 0 to 26 15 0	28 0 0	31 15 0 to 33 0 0	223 10 0 to 224 0 0	227 15 0 to 228 0 0	$43\frac{3}{8}$	$43\frac{1}{2}$	118 9	7
26 5 0 to 27 0 0	28 0 0	32 10 0 to 33 15 0	225 10 0 to 226 0 0	229 10 0 to 229 15 0	43	$43\frac{1}{8}$	118 7	8
26 0 0 to 26 15 0	28 0 0	31 10 0 to 33 12 6	228 0 0 to 228 10 0	232 0 0 to 232 5 0	$39\frac{3}{4}$	40	119 0	9

14s. 7d.; October 1920, £40. 5s. 6d.; November 1919, £46. 17s. 3d.; October 1919, £43. 17s. 11d.

Zinc Dust. — High-grade Australian has fallen from £85 to £80 per ton.

Antimony.—Prices have declined, English regulus of ordinary brands now being quoted at £45 per ton, but lower prices are quoted for large quantities, values ranging down to £42 per ton. Special brands are quoted at from £48 to £43. 10s. according to quantity. In regard to foreign material, this has also been rather easier, and stands at around £38 for material on spot.

Arsenic.—Business is very quiet, and the quotation is now £71 per ton delivered London and Liverpool.

Bismuth.—A certain amount of business has been moving, and the quotation is unaltered at 12s. 6d. per lb.

Cadmium.—This market is not active, and the quotation stands at about 6s. to 6s. 3d. per lb.

Aluminium.—The price is still quoted at £165 per ton for the home trade, and has been reduced to the same figure for export.

Nickel.—The price has been reduced £15 per ton to £215 for home and export.

Cobalt Metal.—Business has not been active, and the quotation may be called 27s. to 30s. per lb.

Cobalt Oxide.—The price of black oxide is at present about 17s. 6d. and grey 18s. 6d. per lb.

Platinum.—Values are again lower, the present quotation being about £23 per oz. It is understood that some quantities of Russian platinum are available for sale in Norway.

Palladium.—The quotation for this article is also lower at £22 per oz.

Quicksilver.—This market has been very quiet, the business doing being confined to retail lots. The chief producers still maintain their price at £15. 10s. per bottle. The market quotation, however, does not seem to be any better than £15. 5s. to £15. 10s. per bottle, values being weakened by cheap offerings of Italian for forward shipment.

Selenium.—10s. 6d. to 13s. per lb.

Tellurium.—The current quotation is about 95s. to 100s. per lb.

Sulphate of Copper.—The market is very quiet, and quotations are if anything easier, at about £40 to £41 per ton.

Manganese Ore.—The present quotation is about 2s. 10d. per unit c.i.f. United Kingdom or Continent.

Tungsten Ores.—Wolfram 65% stands at about 20s. to 22s. per unit. c.i.f.

Silver.—The market opened the month at $52\frac{3}{4}$d. per oz. for spot standard bars, and prices improved until on November 10 it touched $54\frac{5}{8}$d. per oz. Subsequently the tendency was downward, the quotation at the end of the month being $43\frac{7}{8}$d. per oz.

Graphite.—This market is quiet, and the tendency is apparently easier, although there is no quotable alteration in prices. Soft velvety flake 85 to 90% stands at £60 to £80 per ton, while Madagascar, 80 to 90%, is about £21 to £25 per ton.

Molybdenite.—The quotation is rather nominal at 65s. per unit, c.i.f. United Kingdom.

Chrome Ores.—The present price of 48 to 52% is about £8 per ton c.i.f.

Iron and Steel.—Business has been rather slow to get properly started again after the stoppage caused by the coal strike. The blast-furnaces have duly been got going again, but in many cases are only turning out inferior grades, and not foundry iron, and it is foundry iron that is wanted. Therefore, although it is hoped soon to open up business with over-seas markets in Cleveland iron, it does not appear as if there would be any of this description available yet awhile for export. In the meanwhile, Continental iron is being offered in this market, and it looks as if there would have to be a drastic readjustment of prices soon in the quotations named by makers in this country. So far, however, apparently the home demand has been sufficient to obviate the necessity of such a course, but with Continental offers insistent, this state state of affairs cannot be expected to continue. In regard to manufactured iron and steel, the same remarks apply. Iron and semi-finished steel are being offered here at very cut prices, the present exchange rates with the Continent making this business practicable. As a result of this, it looks as if steel prices would have to be drastically altered also. So far there have been certain reductions made, but buyers are still rather chary about committing themselves, and it looks as if prices would have to come down further.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total
	Oz.	Oz.	Oz.
Year 1919	8,111,271	218,820	8,330,091
January 1920	653,295	17,208	670,503
February	607,918	17,412	625,330
March	689,645	17 391	707,036
April	667,926	19,053	686,979
May	681,551	17,490	699,041
June	699,199	16,758	715,957
July	718,521	17,578	736,099
August	683,604	18,479	702,083
September	665,486	16,687	682,173
October	645,819	16,653	662,472

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
September 30, 1919	169,120	12,392	5,294	186,806
October 31	167,499	12,691	4,492	184,682
November 30	164,671	12,565	4,337	181,573
December 31	166,155	12,750	4,271	183,176
January 31, 1920	176,390	12,766	4,796	193,952
February 29	185,185	12,708	5,217	203,110
March 31	188,564	12,788	5,232	206,584
April 30	189,446	12,951	5,057	207,454
May 31	184,722	12,897	4,793	202,412
June 30	179,827	13,036	4,596	197,459
July 31	174,187	13,005	4,521	191,713
August 31	169,263	13,535	4,244	187,042
September 30	163,132	13,716	4,323	181,171
October 31	159,426	13 858	4,214	177,498

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 65% of the working profit. Figures for yield and profit for 1919 based on par value of gold; subsequently gold premium included.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
July, 1919	2,134,668	27 10	21 9	6 0	611,118
August	2,036,128	28 5	22 11	5 5	551,203
September	2,019,109	28 6	22 10	5 7	560,979
October	2,108,698	28 3	22 6	5 10	612,841
November	1,933,526	28 8	23 5	5 5	521,472
December	1,845,088	28 8	25 6	3 10	354,098
Year 1919	24,043,638	28 7	22 11	5 6	6,605,509
January, 1920	2,038,092	34 4	24 2	10 2	1,036,859
February	1,869,180	35 1	28 3*	6 10*	644,571*
March	2,188,104	31 8	25 2	6 6	716,610
April	2,065,446	31 5	26 3	5 2	533,940
May	2,117,725	31 9	25 11	5 10	618,147
June	2,146,890	31 10	25 2	6 8	692,510
July	2,194,050	33 6	24 6	9 0	985,058
August	2,057,560	36 11	25 0	11 11	1,226,906
September	1,950,410	38 11	25 6	13 5	1,276,369

* Results affected by the back-pay disbursed in accordance with new wages agreement.

Production of Gold in Rhodesia and West Africa.

	Rhodesia		West Africa	
	1919	1920	1919	1920
	£	oz.	£	
January	211,917	43,428	104,063	
February	220,885	44,237	112,616	
March	225,808	45 779	112,543	
April	213,160	47,000	109,570	
May	218,057	46,266	100,827	No official returns published.
June	214,215	45,054	106,612	
July	214,919	46,208	102,467	
August	207 339	48,740	103,112	
September	223,719	45,471	100,401	
October	204,184	47,343	91,352	
November	186,462	—	98,322	
December	158,835	—	98,806	
Total	2,499,498	459,526	1,240,691	

Transvaal Gold Outputs.

	September		October	
	Treated	Yield	Treated	Yield
	Tons	Oz.	Tons	Oz.
Aurora West	9,850	£14,879*	9,400	£14,858*
Brakpan	56,850	23,724	56,000	24,629
City Deep	84,000	33,837	75,000	30,587
Cons. Langlaagte	39,500	£68,442*	39,200	£67,851*
Cons. Main Reef	49,000	17,190	47,000	16,500
Crown Mines	179,000	56,640	179,000	55,473
Durban Roodepoort Deep	21,800	7,351	23,000	7,331
East Rand P.M.	119,000	33,687	119,000	31,641
Ferreira Deep	32,000	11,802	30,700	11,219
Geduld	44,100	15,347	44,500	15,757
Geldenhuis Deep	48,400	13,064	45,300	12,473
Glynn's Lydenburg	3,616	£7,838*	3,060	£7,317*
Goch	13,500	£17,499*	12,900	£18,111*
Government G.M. Areas	133,500	£295,180*	135,000	£315,633*
Kleinfontein	47,800	12,660	43,800	12,458
Knight Central	27,000	7,158	24,400	6,507
Knights Deep	46,850	7,510	—	—
Langlaagte Estate	38,700	£67,089*	41,500	£68,456*
Luipaard's Vlei	16,060	£23,330*	14,740	£21,781*
Meyer & Charlton	13,300	£48,895*	12,600	£48,733*
Modderfontein	86,000	43,671	94,000	47,358
Modderfontein B	53,000	28,983	55,000	28,705
Modderfontein Deep	42,700	21,920	42,600	21,927
Modderfontein East	24,200	9,857	26,600	10,916
New Unified	11,200	£14,960*	10,800	£14,746*
Nourse	42 000	13,118	44,700	13,852
Primrose	20,000	£22,839*	20,000	£23,884*
Princess Estate	—	884	—	553
Randfontein Central	116,000	£179,488*	104,500	£172,433
Robinson	41,300	8,702	39,200	7,902
Robinson Deep	50,300	15,921	49,100	14,881
Roodepoort United	24,600	£26,918	22,000	26,189
Rose Deep	52,000	13,219	47,500	12,067
Simmer & Jack	54,500	12,998	55,800	12,406
Springs	40,000	17,364	38,700	16,450
Sub Nigel	9,500	6,342	10,700	6,049
Transvaal G.M. Estates	16,770	£31,703*	17,430	£36,468*
Van Ryn	31,500	£47,293*	32,100	£51,203*
Van Ryn Deep	47,000	£145,289*	46,600	£142,895*
Village Deep	48,500	15,192	46,000	14,595
Village Main Reef	15,500	4,070	12,300	2,654
West Rand Consolidated	31,600	£50,629*	30,800	£50,140*
Witwatersrand (Knights)	33,500	£59,826*	33,000	£55,471*
Witwatersrand Deep	32,000	8,719	33,100	8,976
Wolhuter	32,800	8,908	33,500	8,398

* Output at £5. 17s. 6d. per oz.

West African Gold Outputs.

	September		October	
	Treated	Value	Treated	Value
	Tons	Oz.	Tons	Oz.
Abbontiakoon	6,558	£11,229	6,401	£11,804*
Abosso	5,500	2,179	5,970	2,390
Akoko	156	131	—	—
Ashanti Goldfields	5,906	7,237	5,856	6,637
Obbuassi	790	£1,805*	694	£1,987*
Prestea Block A	9,439	£15,168*	9,629	£15,577*
Taquah	3,185	1,876	2,810	1,562

* At par.

Rhodesian Gold Outputs.

	September		October	
	Treated	Value	Treated	Oz.
	Tons	£	Tons	
Falcon	15,072	29 774*	15,362	2,983‡
Gaika	3,849	5,516	3,858	1,285
Globe & Phœnix	6,063	6,374†	5,722	7,277
London & Rhodesian	2,195	2,177	—	—
Lonely Reef	5,300	5,257†	5,400	5,344
Planet-Arcturus	4,800	2,141†	5,400	2,460
Rezende	5,600	2,481†	5,700	2,517
Rhodesia, Ltd.	294	111	834	478
Rhodesia G.M. & I.	603	329†	650	315
Shamva	49,850	46,029‖	51,150	£45,204§
Transvaal & Rhodesian	1,500	5,561	1,500	£5,055

* Gold, Silver, and Copper; † Ounces Gold; ‖ Gold at 110s. per oz.
‡ Also 271 tons copper. § Gold at 115s. per oz.

West Australian Gold Statistics.—Par Values.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
October, 1919	586	64,987	65,573	278,535
November	1,171	64,823	65,994	280,323
December	831	27,334	28,165	162,575
January, 1920	836	25,670	26,506	112,590
February	1,928	49,453	51,381	218,251
March	—	54,020	54,020	229,461
April	835	56,256	57,091	242,506
May	227	50,976	51,203	217,495
June	502	56,679	57,181	242,638
July	—	48,341	48,341	205,340
August	167	54,258	54,425	231,185
September	141	54,940	55,081	233,963
October	174	53,801	53,975	229,275
November	128	54,729	54,857	233,017

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1919	1920	1919	1920	1919	1920
	£	Oz.	£	Oz.	£	£
January	36,238	7,105	37,100	4,724	18,000	28,000
February	46,955	8,677	43,330	7,200	24,000	15,000
March	40,267	24,126	48,000	6,973	16,000	22,000
April	63,818	6,368	61,200	8,368	24,000	12,000
May	37,456	13,263	38,200	8,432	16,000	13,800
June	41,465	15,707	44,600	13,725	17,000	8,700
July	37,395	12,782	42,060	9,596	22,000	17,410
August	51,564	12,809	49,700	9,973	20,000	17,168
September	76,340	13,973	37,120	11,789	13,000	13,872
October	39,018	—	36,100	9,300	28,000	24,752
November	40,735	—	32,720	—	51,000	—
December	63,311	—	44,500	—	31,000	—
Total	575,260	113,709	514,630	90,001	280,000	172,702

Australasian Gold Outputs.

	September		October	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Associated G.M. (W.A.)	5,896	7,364	5,601	8,273
Blackwater (N.Z.)	1,657	3,384	1,042	1,411
Bullfinch (W.A.)	5,800	1,711‡	6,000	1,260
Cock's Pioneer (V.)	15,000*	1,294‖	—	—
Golden Horseshoe (W.A.)	11,040	4,812‡	10,560	4,916‡
Great Boulder Pro.(W.A.)	8,543	25,594	8,731	26,327
Ivanhoe (W.A.)	13,155	5,948‡	13,817	5,466‡
Kalgurli (W.A.)	3,204	4,763	3,681	7,702
Lake View & Star (W.A.)	9,355	10,945†	9,892	12,881
Menzies Con. (W.A.)	1,510	2,617	1,500	2,828†
Mount Boppy (N.S.W.)	6,286	9,880	6,002	7,240
Oroya Links (W.A.)	1,376	9,549†	1,627	10,575
Progress (N.Z.)	192	463	—	538
Sons of Gwalia (W.A)	11,529	14,709	12,996	16,065
South Kalgurli (W.A.)	7,293	2,127‡	7,238	2,917
Waihi (N.Z.)	12,805	3,710‡ 29,172§	12,706	4,007‡ 11,691§
Waihi Grand Junc'n (N.Z.)	5,500	1,810‡ 7,905§	—	—
Yuanmi (W.A.)	1,802	4,402	1,533	872‡

† Including royalties; ‡ Oz. gold.; * Cu. yd.; ‖ Also 16 tons tin conc.; § oz. silver.

Miscellaneous Gold and Silver Outputs.

	September		October	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
El Oro (Mexico)	32,000	212,000†	33,000	216,000†
Esperanza (Mexico)	20,983	10,983†‡	—	10,408†‡
Frontino & Bolivia (C'lbia)	2,600	6,756	2,650	7,464
Mexico El Oro (Mexico)	9,355	183,240†	6,875	270,000†
Mining Corp. of Canada	—	158,293*	—	—
Oriental Cons. (Korea)	20,299	75,851†	—	102,040†
Ouro Preto (Brazil)	5,800	2,150‖	5,600	2,044‖
Plymouth Cons. (Calif'rnia)	6,000	7,789	7,600	10,148
St. John del Rey (Brazil)	—	36,000	—	31,000
Santa Gertrudis (Mexico)	44,640	31,598‡	44,444	22,055‡
Sonora (Mexico)	1,160	3,878*	1,252	6,292*
Tomboy (Colorado)	17,000	93,000†	18,000	87,000†

† U.S. Dollars. ‡ Profit, gold and silver. ‖ Oz. gold.
* Oz. silver.

Production of Gold in India.

	1916	1917	1918	1919	1920
	oz.	oz.	oz.	oz.	oz.
January	45,214	44,718	41,420	38,184	39,073
February	43,121	42,566	40,787	36,834	38,872
March	43,702	44,617	41,719	38,317	38,760
April	44,797	43,726	41,504	38,248	37,307
May	45,055	42,901	40,889	38,608	38,191
June	44,842	42,924	41,264	38,359	37,864
July	45,146	42 273	40,229	38,549	37,129
August	45,361	42,591	40,496	37,850	37,375
September	45,255	43,207	40,088	36,813	35,497
October	45,061	43,041	39,472	37,138	35,023
November	45,247	42,915	36,984	39,628	34,522
December	48,276	44,883	40,149	42,643	—
Total	541,077	520,362	485,236	461,171	409,613

Indian Gold Outputs.

	October.		November.	
	Tons Treated	Fine Ounces	Tons Treated	Fine Ounces
Balaghat	3,300	2,367	3,200	2,320
Champion Reef	11,880	5,209	11,676	5,203
Mysore	18,601	12,504	18,169	12,249
North Anantapur	800	941	700	1,001
Nundydroog	8,788	5,528	8,656	5,300
Ooregum	12,900	8,474	12,800	8,449

Base Metal Outputs.

		Sept.	Oct.
Arizona Copper	Short tons copper	1,500	1,400
British Broken Hill	Tons lead conc.	—	—
	Tons zinc conc.	—	—
	Tons carbonate ore	—	—
Broken Hill Block 10	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Burma Corp.	Tons refined lead	2,250	2,200
	Oz. refined silver	251,550	246,260
Fremantle Trading	Long tons lead	360	240
Hampden Cloncurry	Tons copper	543	552
	Oz. gold	349	335
Kafue Copper	Short tons copper	36	—
Mount Lyell	Tons copper	401	401
	Oz silver	12,698	12,779
	Oz. gold	386	392
Mount Morgan	Tons copper	532	523
	Oz. gold	7,695	7,552
North Broken Hill	Tons lead	—	—
	Oz. silver	—	—
Pilbara Copper	Tons ore	102	114
Poderosa	Tons copper ore	500	480
Rhodesian Broken Hill	Tons lead	1,168	1,150
S'th American Copper	Tons copper ore ship'd.	—	1,750
Tanganyika	Long tons copper	—	1,224
Tolima	Tons silver-lead conc.	60	60
Zinc Corp.	Tons zinc conc.	—	—
	Tons lead conc.	—	—

Imports of Ores, Metals, etc., into United Kingdom.

		October.	November.
Iron Ore	Tons	426,179	350,714
Manganese Ore	Tons	46,723	31,448
Copper and Iron Pyrites	Tons	51,316	56,289
Copper Ore, Matte, and Precipitate	Tons	2,850	8,949
Copper Metal	Tons	2,205	6,146
Tin Concentrate	Tons	2,784	2,408
Tin Metal	Tons	2,044	1,786
Lead, Pig and Sheet	Tons	16,128	17,279
Zinc (Spelter)	Tons	4,775	4,589
Quicksilver	Lb.	69,651	71,823
Zinc Oxide	Tons	375	314
White Lead	Cwt.	16,926	8,910
Barytes	Cwt.	51,775	35,681
Phosphate	Tons	39,440	33,477
Sulphur	Tons	238	3,634
Borax	Cwt.	1,067	2,000
Other Boron Compounds	Tons	2,072	12
Nitrate of Soda	Cwt.	413,362	343,856
Nitrate of Potash	Cwt.	26,344	20,447
Petroleum:			
Crude	Gallons	—	—
Lamp Oils	Gallons	16,733,024	9,992,193
Motor Spirit	Gallons	18,340,130	25,631,275
Lubricating Oils	Gallons	6,971,681	11,394,340
Gas Oil	Gallons	3,960,017	4,766 694
Fuel Oil	Gallons	23,939,554	44,223,647
Total Petroleum	Gallons	69,953,994	96,010,535

Outputs of Tin Mining Companies.
In Tons of Concentrate.

	August Tons	Sept. Tons	Oct. Tons
Nigeria:			
Associated Nigerian	–	20	20
Benue	–	–	–
Bisichi	9	11	16
Bongwelli	1	1¾	1½
Dua	2½	3	2½
Ex-Lands	32	35	33
Filani	–	8	5¼
Forum River	11	11	10
Gold Coast Consolidated	4	5	3
Gurum River	14	15	15
Jantar	14	15	10
Jos	18	20½	22½
Kaduna	9½	14¼	13
Kaduna Prospectors	3¾	6¾	9¾
Kano	3	4½	5
Kuru	12	–	12
Kwall	–	–	–
Lower Bisichi	8½	9¼	8¾
Lucky Chance	1½	1	1
Minna	3	2½	3
Mongu	30	31	40
Naraguta	45	45	45
Naraguta Extended	26	24	23
Nigerian Consolidated	23	33⅛	30
Ninghi	4½	4½	6
N.N. Bauchi	47¼	53	55
Offin River	10	–	–
Rayfield	35	35	35
Ropp	57	92	168
Rukuba	–	3½	5½
South Bukeru	6	8½	13
Sybu	2⅞	1⅛	1¼
Tin Fields	11½	8½	8
Yarde Kerri	2½	4	5
Federated Malay States:			
Chenderiang	–	79*	–
Gopeng	60	60	72
Idris Hydraulic	26¾	17¾	18
Ipoh	15	12	13½
Kamunting	–	106*	–
Kinta	30	26	32¾
Lahat	44⅔	53½	59½
Malayan Tin	65½	68½	80⅓
Pahang	216½	183	178⅓
Rambutan	15	13	15
Sungei Besi	30	30	30
Tekka	30	36	30
Tekka-Taiping	33	39	39
Tronoh	28	37	49½
Cornwall:			
East Pool	86	68⅗	69⅛†
Geevor	25¾	–	—
Grenville	–	–	—
South Crofty	54†	54†	55†
Other Countries:			
Aramayo Francke (Bolivia)	153	180	—
Berenguela (Bolivia)	26	30	29
Briseis (Tasmania)	26	21	20
Deebook (Siam)	8½	18	19½
Leeuwpoort (Transvaal)	—	265*	—
Macready (Swaziland)	—	21*	—
Mawchi (Burma)	–	70†	—
Porco (Bolivia)	18	5	—
Renong (Siam)	45½	59½	61⅓
Rooiberg Minerals (Transvaal)	45	50	50
Siamese Tin (Siam)	85¼	53½	60½
Tongkah Harbour (Siam)	76	85	68
Zaaiplaats (Transvaal)	30	30	28

* Three months. † Tin and wolfram.

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1915	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons	Tons
January	417	531	667	678	613	547
February	358	528	646	668	623	477
March	418	547	655	707	606	505
April	444	486	555	584	546	467
May	357	536	509	525	483	383
June	373	510	473	492	484	435
July	455	506	479	545	481	484
August	438	498	551	571	616	447
September	442	535	538	520	561	528
October	511	584	578	491	625	628
November	467	679	621	472	536	—
December	533	654	655	518	511	—
Total	5,213	6,594	6,927	6,771	6,685	4,901

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons
January	4,316	3,558	3,149	3,765	4,265
February	3,372	2,755	3,191	2,673	3,014
March	3,696	3,286	2,608	2,819	2,770
April	3,177	3,251	3,308	2,855	2,606
May	3,729	3,413	3,332	3,404	2,741
June	3,435	3,489	2,950	2,873	2,940
July	3,517	3,253	3,373	3,756	2,824
August	3,732	3,413	3,259	2,955	2 786
September	3,636	3,154	3,166	3,161	2,734
October	3,681	3,436	2,870	3,221	2,837
November	3,635	3,300	3,131	2,972	—
December	3,945	3,525	3,023	2,413	—
	43,871	39,833	37,370	36,867	29,517

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
August 25, 1919	130½	£18,297	£140 4 3
September 8	115½	£16,588	£143 12 6
September 22	135½	£19,557	£144 6 9
October 8	72	£10,867	£150 18 7
October 20	32	£5,093	£159 3 2
November 3	34½	£5,235	£151 15 0
November 17	39	£6,161	£157 19 9
December 1	38	£5,905	£155 8 3
December 15	29	£5,133	£176 10 0
December 31	14¾	£2,884	£195 10 10
Total and Average, 1919	2,858	£366,569	£128 5 0
January 12, 1920	31	£6,243	£201 8 0
January 26	51¾	£10,574	£204 6 10
February 9	37½	£7,880	£210 2 8
February 23	53¾	£12,120	£225 10 0
March 8	18	£4,038	£224 7 7
March 22	44	£8,286	£188 6 8
April 6	44½	£8,367	£188 0 5
April 19	33½	£6,375	£190 6 0
May 3	61½	£11,641	£189 5 9
May 17	44	£6,151	£139 16 0
May 31	10	£1,578	£157 16 0
June 14	24¾	£3,278	£132 9 3
June 28	14½	£1,932	£133 4 10
July 12	43¾	£6,133	£140 4 0
July 26	10½	£1,643	£156 10 0
August 9	10½	£1,664	£158 10 0
August 23	27¼	£4,022	£147 12 0
September 6	19	£2,563	£134 18 6
September 20	10	£1,552	£155 5 0
October 4	9	£1,359	£151 0
October 18	39½	£5,225	£132 5 11
November 1	9	£1,329	£147 14 5
November 15	4½	£597	£132 17 6
November 29	8½	£965	£113 12 0

On November 15 the sales were: Tincroft 4½ tons, average price £132 17s. 6d per ton; on November 29: Tincroft 8½ tons, average price £113 12s. per ton.

Stocks of Tin

Reported by A. Strauss & Co. Long Tons.

	Sept. 30	Oct. 31	Nov. 30
Straits and Australian Spot	1,082	1,043	1,944
Ditto, Landing and in Transit	562	556	620
Other Standard, Spot and Landing	2,641	3,261	2,743
Straits, Afloat	1,494	2,154	1,955
Australian, Afloat	132	179	203
Banca, in Holland	1,770	2,143	2 966
Ditto, Afloat	1,066	1,222	1,095
Billiton, Spot	—	—	721
Billiton, Afloat	73	230	295
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	235	100	300
Total Afloat for United States	5,540	5,363	3 257
Stock in America	3,731	3,191	2,966
Total	18,326	19,442	19,065

Shipments, Imports, Supply, and Consumption of Tin.

Reported by A. Strauss & Co. Long tons.

	Sept.	Oct.	Nov.
Shipments from :			
Straits to U.K.	1,369	1,470	1,505
Straits to America	2,900	1,770	825
Straits to Continent	260	100	300
Straits to Other Places	—	165	199
Australia to U.K.	235	350	350
U.K. to America	775	225	175
Imports of Bolivian Tin into Europe	1,153	1,117	2,172
Supply :			
Straits	4,529	3,340	2,630
Australian	235	350	350
Billiton	143	542	482
Banca	429	1,148	1,154
Standard	1,092	1,305	475
Total	6,428	6,685	5,091
Consumption :			
U K. Deliveries	2,214	1,670	1,607
Dutch „	223	126	215
American „	5,635	3,465	3,420
Straits, Banca & Billiton, Continental Ports, etc.	182	308	226
Total	8 254	5,569	5,468

Dividends Declared by Mining Companies.

Date	Company	Par Value of Shares	Amount of Dividend
Nov. 11	Ashanti Goldfields	4s.	20% less tax
Dec. 3	Berenguela Tin	4s.	15% less tax
Nov. 20	Cassel Cyanide	5s.	1s less tax
Nov. 18	Central Mining	£8.	6s. tax paid
Dec. 8	Chinese Engineering & Mining	£1.	20% tax paid
Dec. 9	Frontino & Bolivia	£1.	5% less tax
Nov. 17	Gaika	£1.	7½% less tax
Nov. 18	Globe and Phœnix	5s.	1s. 6d. tax paid
Nov. 18	Golden Horse-Shoe	£5.	3s. tax paid
Nov. 17	Great Boulder	2s.	9d. less tax
Nov. 12	Idris	£1.	1s. less tax
Dec. 4	Ivanhoe	£5.	1s. 6d. less tax
Nov. 19	Kaduna	5s.	10% less tax
Dec. 4	Kalgurli Gold	£1.	4s. less tax
Nov. 26	Koffyfontein Diam'ds	£1.	7½% less tax
Nov. 22	Kamunting Tin	£1.	5% tax paid
Nov. 20	Kramat Pulai	£1.	1s. less tax
Nov. 20	Malayan Tin Dredging	£1.	1s. less tax
Dec. 4	Mexico of El Oro	£1.	4s. tax paid
Nov. 16	Middleburg Steam Coal & Coke	£1.	6¼% less tax
Nov. 16	Naraguta Tin	£1.	5% tax paid
Nov. 22	Nechi Mines	Pref. 10s.	1s. 3d. less tax
Nov. 22	New Consolidated Goldfields	£1.	6% tax paid
Nov. 20	Oceana Consolidated	5s.	10% less tax
Dec. 9	Oroville Dredging	£1.	9d. less tax
Nov. 24	Pahang Consolidated	Ord. 5s.	15% less tax
		Pref. £1.	11½% less tax
Dec. 9	Pato Mines	£1.	7s. less tax
Nov. 16	Rambutan	£1.	8d. less tax
Dec. 9	Shamva Mines	£1.	7½% less tax
Nov. 20	St. John del Rey	Pref. £1.	1s tax paid
		Ord. £1	9d. less tax
Dec. 3	South African Diamond	£1.	2s. 6d. less tax
Nov. 12	Sungei Besi	£1.	1s. less tax
Nov. 12	Tronoh	£1.	1s. less tax
Nov. 15	Weardale Lead	£1.	10% tax paid
Nov. 18	Wolhuter	£1.	1s. 3d. less tax
Nov. 22	Zungon Tin	1s.	7%

PRICES OF CHEMICALS. December 8.

These quotations are not absolute; they vary according to quantities required and contracts running.

		£	s.	d.
Alum	per ton	20	0	0
Alumina, Sulphate of	„	17	0	0
Ammonia, Anhydrous	per lb.		2	6
„ 0·880 solution	per ton	46	0	0
„ Carbonate	per lb.			6½
„ Chloride of, grey	per ton	60	0	0
„ „ „ pure	per cwt.	5	10	0
„ Nitrate of	per ton	50	0	0
„ Phosphate of	„	105	0	0
„ Sulphate of	„	24	10	0
Antimony Sulphide, Golden	per lb.		1	6
Arsenic, White	per ton	78	0	0
Barium Sulphate	„	12	0	0
Bisulphate of Carbon	„	60	0	0
Bleaching Powder, 35% Cl.	„	26	0	0
Borax	„	41	0	0
Copper, Sulphate of	„	40	0	0
Cyanide of Sodium, 100%	per lb.		1	0
Hydrofluoric Acid	„			7½
Iodine	„		16	0
Iron, Sulphate of	per ton	4	0	0
Lead, Acetate of, white	„	66	0	0
„ Nitrate of	„	60	0	0
„ Oxide of, Litharge	„	58	0	0
„ White	„	64	0	0
Lime, Acetate, brown	„	18	0	0
„ „ grey 80%	„	25	0	0
Magnesite, Calcined	„	22	0	0
Magnesium, Chloride	„	13	0	0
„ Sulphate	„	12	0	0
Methylated Spirit 64° Industrial	per gal.		7	4
Phosphoric Acid	per lb.			
Potassium Bichromate	per lb.		1	4
„ Carbonate 85%	per ton	80	0	0
„ Chlorate	per lb.		0	8
„ Chloride 80%	per ton	40	0	0
„ Hydrate (Caustic) 90%	„	90	0	0
„ Nitrate	„	55	0	0
„ Permanganate	per lb.		3	6
„ Prussiate, Yellow	„		1	10
„ Sulphate, 90%	per ton	35	0	0
Sodium Metal	per lb.		1	3
„ Acetate	per ton	52	0	0
„ Arsenate 45%	„	60	0	0
„ Bicarbonate	„	9	0	0
„ Bichromate	per lb.			11
„ Carbonate (Soda Ash)	per ton	16	0	0
„ „ (Crystals)	„	7	0	0
„ Chlorate	per lb.			5½
„ Hydrate, 76%	per ton	28	0	0
„ Hyposulphite	„	25	0	0
„ Nitrate, 95%	„	24	0	0
„ Phosphate	„	38	0	0
„ Prussiate	per lb.		1	2
„ Silicate	per ton	11	0	0
„ Sulphate (Salt-cake)	„	8	0	0
„ „ (Glauber's Salts)	„	9	0	0
„ Sulphide	„	36	0	0
Sulphur, Roll	„	17	0	0
„ Flowers	„	17	0	0
Sulphuric Acid, Fuming, 65°	„	24	0	0
„ „ free from Arsenic, 144°	„	6	5	0
Superphosphate of Lime, 18%	„	5	0	0
Tartaric Acid	per lb.		2	2
Tin Crystals	„		1	11
Zinc Chloride	per ton	27	0	0
Zinc Sulphate	„	22	10	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Dec. 5 1919 £ s. d.	Dec. 7 1920 £ s. d.
RAND:		
Brakpan	3 17 6	2 17 6
Central Mining (£8)	11 10 0	7 5 0
City & Suburban (£4)	9 0	6 6
City Deep	3 5 0	2 7 6
Consolidated Gold Fields	3 1 3	1 1 3
Consolidated Langlaagte	1 6 3	15 0
Consolidated Main Reef	14 9	13 0
Consolidated Mines Selection (10s.)	1 13 6	18 3
Crown Mines (10s.)	3 12 6	2 7 6
Daggafontein	1 3 3	10 0
Durban Roodepoort Deep	10 0	5 0
East Rand Proprietary	11 6	7 0
Ferreira Deep	12 6	8 9
Geduld	3 2 6	2 8 9
Geldenhuis Deep	13 9	6 6
Gov't Gold Mining Areas	5 5 0	4 2 6
Heriot	12 0	8 6
Johannesburg Consolidated	1 12 6	1 4 6
Jupiter	8 0	1 6
Kleinfontein	15 0	6 3
Knight Central	7 6	4 6
Knights Deep	10 9	7 3
Langlaagte Estate	1 0 6	13 9
Meyer & Charlton	4 15 0	4 7 6
Modderfontein (10s.)	32 0 0	3 8 9*
Modderfontein B (5s.)	9 5 0	1 10 0‡
Modderfontein Deep (5s.)	2 12 6	2 2 6
Modderfontein East	1 11 3	1 1 3
New State Areas	1 12 6	1 7 6
Nourse	15 6	8 6
Rand Mines (5s.)	3 15 0	2 8 9
Rand Selection Corporation	5 7 6	2 15 0
Randfontein Central	19 6	11 6
Robinson (£5)	14 0	7 6
Robinson Deep A (1s.)	1 3 9	12 6
Rose Deep	1 3 0	16 3
Simmer & Jack	7 3	3 0
Simmer Deep	3 0	3
Springs	3 1 3	1 15 0
Sub-Nigel	1 1 3	13 9
Union Corporation (12s. 6d.)	1 4 3	16 6
Van Ryn	1 2 6	13 9
Van Ryn Deep	5 0 0	3 12 6
Village Deep	17 9	8 6
Village Main Reef	9 6	4 6
West Springs	1 8 9	16 3
Witwatersrand (Knight's)	1 2 6	12 6
Witwatersrand Deep	11 6	6 6
Wolhuter	5 6	5 3
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	16 3	10 0
Transvaal Gold Mining Estates	15 0	9 6
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	30 0 0	13 0 0
Jagersfontein	7 5 0	3 0 0
Premier Deferred (2s. 6d.)	13 10 0	6 10 0
RHODESIA:		
Cam & Motor	10 0	8 6
Chartered British South Africa	1 1 6	13 6
Falcon	14 3	10 6
Gaika	16 6	11 0
Globe & Phœnix (5s.)	17 6	19 6
Lonely Reef	3 2 6	2 10 0
Rezende	4 12 6	2 15 0
Shamva	2 2 6	1 10 0
Willoughby's (10s.)	6 6	5 0
WEST AFRICA:		
Abbontiakoon (10s.)	3 9	2 6
Abosso	13 9	7 6
Ashanti (4s.)	1 5 0	15 0
Prestea Block A	5 6	2 0
Taquah	16 3	11 3
WEST AUSTRALIA:		
Associated Gold Mines	4 0	3 0
Associated Northern Blocks	3 6	3 0
Bullfinch	3 6	2 3
Golden Horse-Shoe (£5)	1 6 3	17 6
Great Boulder Proprietary (2s.)	9 9	6 9
Great Fingall (10s).	1 9	1 6
Hampton Properties	1 12 6	6 3
Ivanhoe (£5)	1 18 9	1 2 6
Kalgurli	12 6	12 6
Lake View Investment (10s.)	1 1 0	13 0
Sons of Gwalia	8 6	6 0
South Kalgurli (10s.)	5 6	6 6

GOLD, SILVER, *cont.*	Dec. 5 1919 £ s. d.	Dec. 7 1920 £ s. d.
OTHERS IN AUSTRALASIA:		
Blackwater, New Zealand	8 9	8 9
Consolidated G.F. of New Zealand	3 9	3 9
Mount Boppy, N.S.W. (10s.)	4 6	2 9
Progress, New Zealand	1 9	1 9
Talisman, New Zealand	8 9	6 6
Waihi, New Zealand	2 15 0	1 10 0
Waihi Grand Junction, New Z'lnd	13 6	8 9
AMERICA:		
Buena Tierra, Mexico	15 0	6 3
Camp Bird, Colorado	1 1 0	8 6
El Oro, Mexico	15 6	12 6
Esperanza, Mexico	16 6	1 1 3
Frontino & Bolivia, Colombia	12 6	8 9
Le Roi No. 2 (£5), British Columbia	11 3	4 0
Mexico Mines of El Oro, Mexico	7 10 0	6 0 0
Nechi (Pref. 10s.), Colombia	12 0	8 6
Oroville Dredging, Colombia	1 7 6	1 3 9
Plymouth Consolidated, California	1 3 9	17 6
St. John del Rey, Brazil	18 0	14 6
Santa Gertrudis, Mexico	1 13 6	14 3
Tomboy, Colorado	13 9	7 6
RUSSIA:		
Lena Goldfields	1 8 9	15 0
Orsk Priority	15 0	10 0
INDIA:		
Balaghat (10s.)	4 0	6 6
Champion Reef (2s. 6d.)	4 0	2 3
Mysore (10s.)	16 3	12 6
North Anantapur	5 3	5 0
Nundydroog (10s.)	16 6	2 6
Ooregum (10s.)	17 6	10 0
COPPER:		
Arizona Copper (5s.), Arizona	2 0 0	1 17 6
Cape Copper (£2), Cape and India	2 7 6	17 6
Esperanza, Spain	5 9	5 0
Hampden Cloncurry, Queensland	16 6	7 6
Mason & Barry, Portugal	2 2 6	1 10 0
Messina (5s.), Transvaal	5 0	4 0
Mount Elliott (£5), Queensland	4 5 0	1 0 0
Mount Lyell, Tasmania	1 5 6	16 6
Mount Morgan, Queensland	1 3 9	12 6
Mount Oxide, Queensland	9 0	3 9
Namaqua (£2), Cape Province	1 15 0	1 7 6
Rio Tinto (£5), Spain	45 0 0	24 10 0
Russo-Asiatic Consd., Russia	—	10 6
Sissert, Russia	1 1 3	11 3
Spassky, Russia	1 10 0	15 0
Tanganyika, Congo and Rhodesia	3 7 6	1 5 0
LEAD-ZINC:		
BROKEN HILL:		
Amalgamated Zinc	1 6 0	1 1 3
British Broken Hill	2 5 0	1 5 0
Broken Hill Proprietary (8s.)	2 12 0	2 6 3
Broken Hill Block 10 (£10)	1 6 3	17 6
Broken Hill North	2 15 0	1 17 6
Broken Hill South	2 7 6	1 16 3
Sulphide Corporation (15s.)	1 3 6	15 9
Zinc Corporation (10s.)	1 2 0	14 0
ASIA:		
Burma Corporation (10 rupees)	12 12 6	9 0†
Russian Mining	15 0	7 6
RHODESIA:		
Rhodesia Broken Hill (5s.)	14 6	8 0
TIN:		
Aramayo Francke, Bolivia	4 8 9	2 17 6
Bisichi, Nigeria	15 6	8 0
Briseis, Tasmania	4 6	4 3
Dolcoath, Cornwall	8 0	1 9
East Pool (5s.) Cornwall	16 6	8 0
Ex-Lands Nigeria (2s.), Nigeria	3 3	2 6
Geevor (10s.) Cornwall	19 3	6 3
Gopeng, Malay	2 0 0	1 12 6
Ipoh Dredging, Malay	17 6	13 9
Kamunting, Malaya	2 5 0	2 10 0
Kinta, Malaya	2 10 0	2 0 0
Malayan Tin Dredging, Malay	2 2 6	1 10 0
Mongu (10s.), Nigeria	1 2 6	15 0
Naraguta, Nigeria	16 3	12 6
N. N. Bauchi, Nigeria (10s.)	8 0	3 3
Pahang Consolidated (5s.), Malay.	14 3	9 0
Rayfield, Nigeria	12 6	5 6
Renong Dredging, Siam	2 13 9	1 15 0
Ropp (4s.), Nigeria	1 6 6	7 9
Siamese Tin, Siam	3 2 6	2 15 0
South Crofty (5s.), Cornwall	18 6	10 6
Tehidy Minerals, Cornwall	1 7 6	11 3
Tekka, Malay	4 12 6	1 0 0§
Tekka-Taiping Malay	6 12 6	1 2 6§
Tronoh, Malay	2 12 6	1 7 6

* £4 shares split into 8 of 10s. each. ‡ £1 shares split into 4 of 5s. each. † 10-rupee shares of Indian Co. § New shares.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

BOLIVIAN TIN-SILVER ORES.

In *Economic Geology* for September, W. Myron Daly writes at some length on the deposition of Bolivian tin-silver ores. The Bolivian ores have always been troublesome to the theorists as to the genesis of ore deposits, and any discussion of the subject is of interest. The object of the present paper is to show that the sequence of ore deposition in Bolivia does not require any exceptional line of explanation.

The tin deposits of Bolivia extend along the lines of the Cordillera Real and its south-eastward extension from north of La Paz to the south-eastern part of the department of Potosi. The mines are at elevations from about 12,000 ft. to nearly 20,000 ft., the higher ones especially being in rugged, wind-swept, and snow-clad country where none but the native Indian can work. The granite core of the range is flanked by shales, sandstones, conglomerates, and quartzites, which in many cases abut sharply against the contact, and into which the granite has sent numerous apophyses and dykes of porphyry. The relations of the granite to the sedimentaries are clearly those of intrusion. South of Quimsa Cruz exposures of the granite core have been recorded only in small areas several miles from Potosi. There are innumerable exposures of porphyries throughout the southern district similar in nature to the porphyries associated with the granite in the north, and there seems good reason to believe that the granite extends southward under the sedimentaries and more recent igneous flows. An examination of the topography indicates that the southern area, as lofty as it is, lacks the sharp ruggedness of Illampu and Illimani in the northern granite area, and suggests that the top of the great batholith reached higher levels in the north, with subsequent more rapid removal of the covering material.

The intruded sediments have been identified as Silurian and Devonian from their fossil content in the north where found with granite. Similar appearing rocks intruded by the porphyry in the south were long considered to be of the same age, but in the vicinity of Potosi the shales seem to have been definitely fixed as late Tertiary.

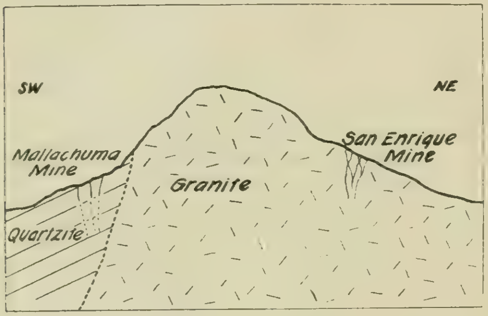
There is no reason to doubt that the tin mineralization took place at approximately the same period throughout the entire district. Therefore, since most of the northern deposits are just as clearly related in age to the crystalline granites as are most of the southern tin occurrences to their associated porphyries, it follows that the granite and the porphyries are of approximately the same age, the latter being an expression of the hypabyssal and volcanic conditions surrounding their solidification. The age correlation of these two types, rather than their absolute age, most concerns the author's genetic theory of the origin of the tin veins, but if the porphyries were intruded in late Tertiary time, and this seems to be established, then the granite core and the elevation of the Cordillera Real of Bolivia must be of approximately the same age. This may seem startling in view of their long accepted Paleozoic origin, but the earlier geologists of the region based their age interpretations upon no more positive evidence than the fact that Silurian and Devonian sediments had been intruded by the granites. This proves only that they were post-Devonian. The youngest rocks intruded define the age, and in this case later discoveries have shown these to be late Tertiary. The occurrence of wide-spread igneous activity at the end of the Tertiary in other parts of the world is consistent with a similar age for the intrusions of this region.

The mineralization has been distributed along the axis of the Cordillera Real and its extensions with great uniformity. The veins occur on both the east and west sides of the range and are found in granite, its related porphyries, and in any and all of the intruded sedimentaries. The mines of Milluni, Huayna Potosi, Araca, Choquetanga, San Enrique, Mallachuma, Quimsa Cruz, and Santa Vela Cruz are grouped along the west and south border of the granite area. All of the rest, including Oruro, Negro Pabellon, Llallagua, Uncia, Avicaya, Potosi, Porco, Pulacayo, and many others, are found in or about intrusions of quartz-porphyry or related types, with the exception of one or two occurrences where the workings have not exposed the igneous rocks. Granite outcrops in small areas near Potosi and, of course, may be at no great depth beneath the surface in many places. Especially probable does the proximity of the granite seem in the vicinity of Uncia, Llallagua, and Avicaya, as indicated by the likeness of this group of deposits to those actually found in and about the granite itself.

The veins vary from fissure veins, usually not more than one metre in width, with filling of ore and gangue and with mineralization of the wall of greater or less extent, to mineralized breccia zones, sometimes many metres in width. Crusted fillings of cavities and banded structures in connection with them point to deposition in open fissures, but veins formed by replacement processes also occur. The fissures are usually steeply-dipping breaks and shrinkage cracks in the igneous rocks and equally steep fractures along or across the bedding in the sedimentary rocks.

In veins found within the granite, as illustrated at the San Enrique mine, the mineralization has been of a distinctly simple type, tourmaline and cassiterite, in varying proportions, constituting practically all of the ore. This mineral composition is found in veins of other countries where the genetic relations to granitic rocks is clearly defined and where all factors point to ore deposition under conditions of the high-temperature zone. Moreover, at the San Enrique mine, the granite is apparently the only igneous rock present, and it seems logical to apply the same reasoning which all investigators have used in genetically connecting the tin-silver veins to the south with the porphyries in which they are found. Thus the character of the including rock as well as the mineralization makes it impossible to assign to these veins any but a deep-zone origin, and they are here classed as the highest temperature facies among the tin deposits of the region.

Not far removed genetically from the veins within the granite are those just across the contact in the intruded sediments. At the Mallachuma mine, a few miles south-west of the San Enrique, the veins are in the sediments not far from the granite contact. Though abundant cassiterite and some tourmaline persist, the vein-filling includes pyrrhotite, pyrite, arsenopyrite, chalcopyrite, and quartz, all of which except pyrrhotite being common in other veins of the province which clearly formed under conditions of the intermediate vein zone. Here slightly lower temperature conditions must, of necessity, have prevailed and it is possible to trace the change in the character of the mineralization which paralleled the fall in temperature and pressure. Thus it is apparent that the mineralization here confirms the structural relations in indicating that ore deposition took place under temperatures and pressures slightly less intense than in the case of veins in the granite.



Section showing relations of Veins to including Rock at San Enrique and Mallachuma Mines.

Araca, Milluni, Huayna Potosi, Quimsa Cruz, and Santa Vela Cruz are also in the sedimentaries, grouped about the granite at varying distances from the contact. There are differences in their characters which will be described later, but they range from typical high-temperature veins with abundant tourmaline to somewhat lower temperature types with little or no tourmaline. None of these deposits could be classed as of the intermediate-zone type, however, their relative nearness to the granite and their mineral content requiring higher temperature conditions.

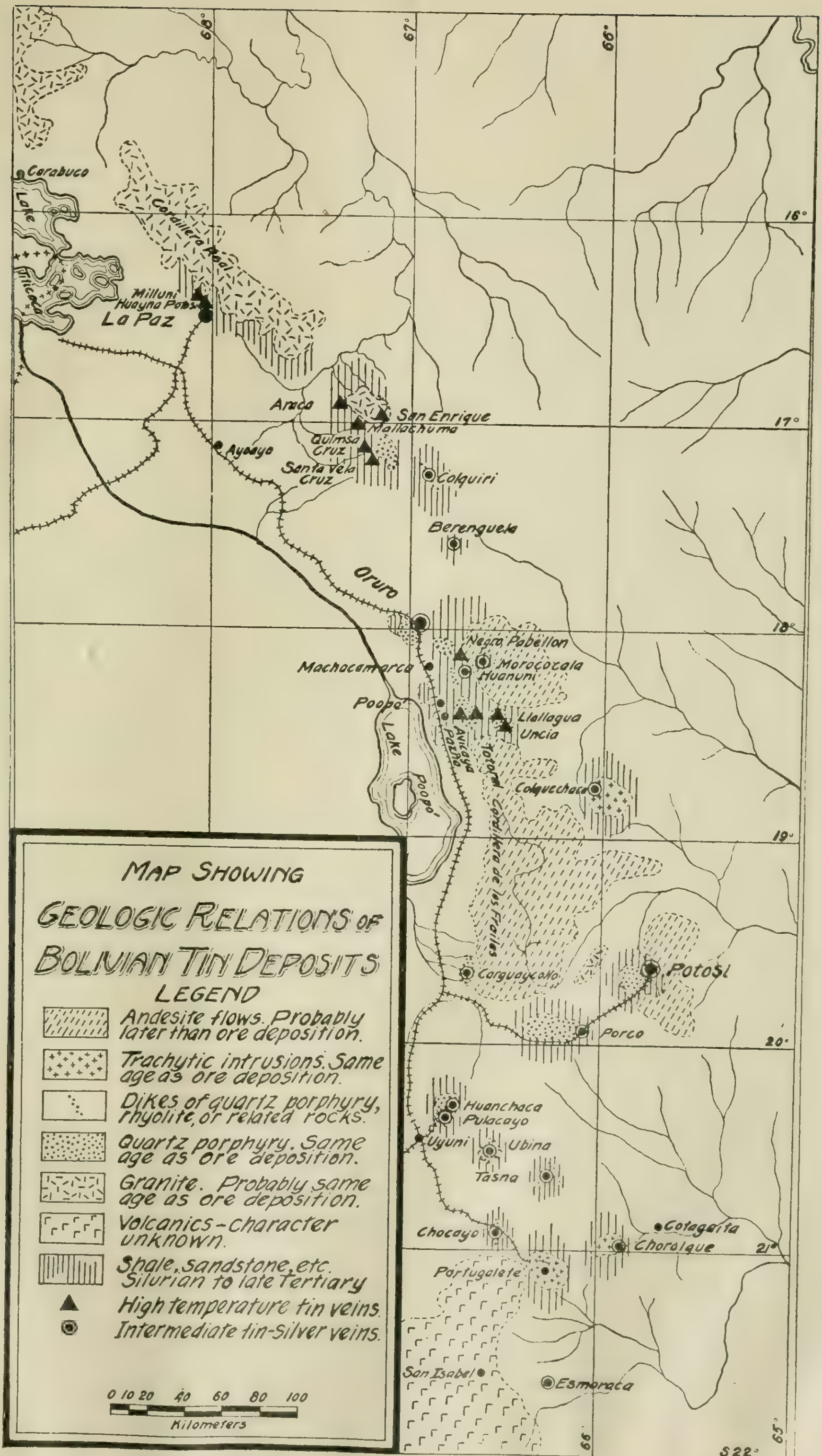
More than one hundred miles south-east of the southern edge of the exposed granite are the deposits at Uncia, Llallagua, Avicaya, etc., grouped in an area of numerous porphyritic intrusions accompanied by intensive silicification and tourmalinization. The ores consist of massive cassiterite, pyrite, bismuthinite and quartz, with abundant tourmaline locally. Some arsenopyrite is present, but other sulphides are rare and in small quantities. The mineralization is clearly that of the northern high-temperature deposits, which, combined with the coarseness of much of the porphyry and the intensive impregnation of the material surrounding many of the veins, strongly points to ore deposition under conditions simulating those of the high temperature zone. This can be explained either by close proximity to the underlying granite core, which is entirely possible, or by supposing that numerous closely-spaced intrusive masses of moderate size created conditions of temperature approaching those near a large plutonic body. These are in reality not two explanations, since both conditions might very likely co-exist. Certain it is that there is no factor in the occurrence of this group of high temperature tin veins which is not plausibly explained in accordance with the general genetic theory here developed.

Another class of deposits, characterized by quite different mineralization from the preceding, comprises the complex sulphide ores associated with porphyries, and in some cases, volcanic igneous rocks. These deposits are in no place near granites or other plutonic rocks, and their structural and field relations entirely support the mineral evidence pointing to an origin under conditions of temperature and pressure likely to characterize the intermediate vein zone. Though cassiterite is common to all the tin veins, being found in most of the sulphide ores, minerals such as tourmaline, topaz, pyrrhotite, etc., are present only in very small amount in any except the high temperature deposits. Stannite, tetrahedrite, jamesonite, arsenopyrite, and some complex bismuth minerals are abundant in many of these intermediate veins, though absent or rare in the former type. Locally there are found complex sulphides of lead, tin, and antimony, such as cylindrite and related minerals, occurring in quantities sufficient to make a distinct type of ore. Silver is associated with all of the sulphide ores, in the tetrahedrite chiefly, but also very widespread in the form of ruby silver which occurs in small amount with all the other sulphides, though it is everywhere very late and may be due entirely to supergene processes. Well crystallized quartz is the dominant gangue mineral throughout. These veins, as pointed out from the field relations, constitute a distinct class in which ore deposition took place at intermediate depths and temperatures.

There is perhaps a third class of veins in the district, in which there is little or no tin. However, all information concerning many of these deposits, which include Pulacayo, Garguaycollo, Colquechaca, Portugalete, and others, dates back to the period before active tin mining in the district, when only the silver was exploited, and small quantities of tin may occur. Nevertheless, since they have not been reopened it is certain that their tin content is negligible as compared to that in deposits such as those at Potosi. Any explanation of these last occurrences must be founded upon a very incomplete knowledge of them, but since in the first two classes considered predominant sulphides with increasing silver content marked the transition from high to intermediate temperature conditions, it is not unreasonable to assume that the silver type, more or less free from tin, represents a stage of mineralization one step further removed from the source than that represented by the tin-silver vein. Support is lent to this suggestion by the volcanic texture of some of the associated rocks. Dacites and rhyolites at Colquechaca and andesite at Portugalete are probably genetically related to the veins, and certainly solidified nearer to the surface and at lower temperature than did the rather coarse-grained porphyries found with so many of the deposits previously considered. The minerals found in these silver districts are much the same as elsewhere in the tin-silver ores, with the exception of the tin minerals, and indicate a temperature of ore deposition probably still within the limits of what may be called the intermediate vein zone.

Supergene processes played a most important rôle during post-depositional periods in the silver-bearing veins, where the most striking enrichment occurred. Oxidized silver minerals with abundant cerargyrite were worked near the surface by the Incas and later by the Spanish conquerors at Porco, Potosi, Oruro, and other places. These ores were followed in depth by large quantities of ruby silver, which, since it is comparatively rare in the still deeper portion of the veins now being worked, was very probably due to supergene deposition.

Tin has also been enriched, but the process has not


MAP SHOWING
GEOLOGIC RELATIONS OF
BOLIVIAN TIN DEPOSITS
LEGEND
Andesite flows. Probably later than ore deposition.
Trachytic intrusions. Same age as ore deposition.
Dikes of quartz porphyry, rhyolite, or related rocks.
Quartz porphyry. Same age as ore deposition.
Granite. Probably same age as ore deposition.
Volcanics-character unknown.
Shale, sandstone, etc. Silurian to late Tertiary
High temperature tin veins.
Intermediate tin-silver veins.
0 10 20 40 60 80 100
Kilometers
68°
67°
66°
65°
16°
17°
18°
19°
20°
21°
S 22°
Carabuco
Lake Titicaca
Cordillera Real
Milluni
Huayna Potosi
La Paz
Araca
San Enrique
Mallachuma
Quimsa Cruz
Ayoayo
Santa Vela Cruz
Colquiri
Berenguela
Oruro
Negro Pabellon
Morococala
Huanuni
Machacamarca
Poopo
Lake Poopo
Avicaya
Pazña
Totoral
Llallagua
Uncia
Colquechaca
Cordillera de los Frailes
Carguaycollo
Potosi
Porco
Huanchaca
Pulacayo
Uyuni
Ubina
Tasna
Chocaya
Cotagaita
Chorolque
Portugalete
San Isabel
Esmoraca

been so clearly defined and simple as in the case of the silver. Removal of more soluble material from the upper portions of the cassiterite veins left oxidized ores, or *pacos*, rich in tin. Cases have also been described where the removal of the oxidizable material has permitted small grains of cassiterite to work downward and become mechanically concentrated along the footwall.

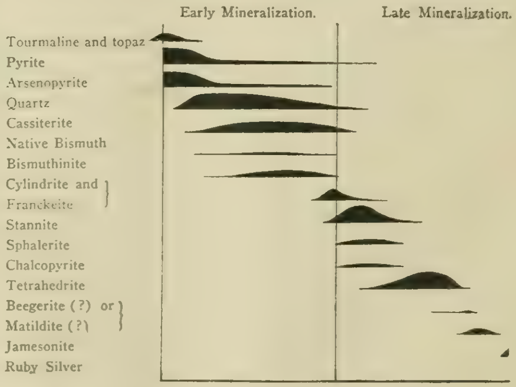
Large quantities of wood-tin occur in many of the upper workings, and while there is no positive evidence as to its source, the obviously oxidized character of the material in which it was invariably observed and its relative abundance in the uppermost portions of the deposits would seem to suggest a supergene origin. A thin section of ore near the surface from the Colorado mine, near Oruro, shows that dark concretionary wood-tin has probably replaced both crystalline quartz and an early yellow cassiterite. The chemistry of this replacement is not clear, but a few suggestions follow from the relations observed. First, the fresh ores in the deposits where wood-tin is abundant contain large amounts of pyrite, and much limonite derived from this pyrite remains. This indicates that the surface waters which acted upon the material were acid solutions, necessitated by the hydrolysis of predominant ferric sulphate in them. Cassiterite is relatively insoluble in acid waters, and consequently the source of the tin for the great quantities of wood-tin present could hardly have been the oxide. It is believed that stannite, which is more abundant than usually reported in the complex sulphide ores, was dissolved during the oxidation and supplied the necessary tin. Between this point and the precipitation of a colloid gel of metastannic acid, from which the wood-tin probably crystallized, there is no bridge. One fact, however, seems clear; quartz and cassiterite were readily dissolved by the solutions which deposited this secondary wood-tin, two minerals notably insoluble in acid solutions. Thus any explanation must account for a pronounced change from acidity to alkalinity in the tin-bearing solutions. This might be explained by calling attention to the fact that the enrichment of tin was probably accompanied by a large-scale enrichment of silver. The deposition of supergene silver sulphides has a reducing action upon the solution, which conceivably may not precipitate their tin during this change from acidity to alkalinity, but throw it down in colloidal form only at some later stage. Satisfactory treatment of this question is made difficult by the lack of experimental chemical work such as has been done in connection with the deposition of supergene minerals of the more common metals.

With the exception of the outbreak of hot waters in the mines at Pulacayo in 1895, none of the mines of the country appear, from the literature, to have encountered ground waters, and consequently, zones of oxidation, supergene sulphide enrichment, and hypogene deposition are all found above the water level.

In describing the ores found throughout the wide extent of the region no attempt is made by the author to cover each individual case. Practically every possible gradation exists between one type and another, but it is nevertheless true that there are certain associations of minerals which are repeated frequently enough to become characteristic and it is these distinct classes of ore that will be dealt with in some detail. Furthermore, as already pointed out, there is a distinct relation existing between the character of the ore and its association with and nearness to the genetically connected igneous rocks. Though this relation is not entirely simple, due to differing conditions with consequent differing ore types in neighbouring veins, it nevertheless affords the most logical criteria for classifying the ores of the region, and, for descriptive purposes, major groups of the deposits are arranged accordingly. The subdivisions are based upon mineral composition and are represented by types studied in the course of this examination. Certain groups of predominant minerals stand out and form the skeleton of the following description of the tin-silver ores. Both thin sections and polished sections have been studied by the author. The following is the author's classification:

I. Deposits of the high-temperature vein zone:
  A. Veins in granite:
    (1) Cassiterite, tourmaline (hematite, pyrite, and quartz).
  B. Veins in invaded rock near granite contact:
    (1) Cassiterite, pyrite, quartz, tourmaline.
    (2) Cassiterite, bismuth, bismuthinite (tourmaline, quartz, pyrite).
  C. Veins in or close to porphyries grading toward granitic types:
    (1) Cassiterite, pyrite, quartz, tourmaline.
    (2) Cassiterite, bismuthinite, pyrite, quartz, tourmaline.

II. Deposits of the intermediate vein zone:
  A. Veins in or close to porphyries grading toward volcanic types:
    (1) Tetrahedrite, stannite, cassiterite, pyrite, arsenopyrite, jamesonite, quartz, etc.
    (2) Cylindrite, franckeite, stannite, sphalerite, cassiterite, pyrite, proustite, quartz.
  B. Veins in invaded rock, but genetically related to porphyry:
    (1) Tetrahedrite, pyrite, sphalerite, chalcopyrite, galena, proustite (probably traces of cassiterite).
  C. Veins in volcanic rock:
    (1) Tetrahedrite, pyrite, sphalerite, chalcopyrite, galena, proustite (probably traces of cassiterite.)



Sequence of Mineral Deposition in the Bolivian Tin-Silver Deposits.

An effort has been made by the author to determine a clearly defined general sequence of mineral deposition for the Bolivian tin-silver district, since in this way it is possible to arrive at an understanding of the changes that take place in the character of the mineralizing solutions. The microscopic examination of massive mixed ores in polished sections has enabled more intimate studies of these mineral relations to be made than was heretofore possible. The accompanying sketch gives the sequence of the more abundant minerals, the thickest portion of each line representing the period of maximum deposition of the mineral.

It is not possible to give a sharply cut sequence such as could be represented by a list of names in order, where each mineral is shown as forming only after the cessation of formation of a preceding one, because the various periods of deposition clearly overlap. Distinctly banded specimens often show one or two minerals such as quartz and pyrite persisting throughout several bands, with a different group of associated minerals in each band. In such cases there can be no question but that the period of deposition of such quartz and pyrite overlaps that of several of the associated minerals. However, any one band examined microscopically will show an apparent order of crystallization within the band. The quartz may be moulded about pyrite crystals and therefore appear to be deposited later, though both may be present in the following layer. Other minerals in any one band may be moulded against crystal forms of both quartz and pyrite, therefore appearing later, but in the following layer they are absent, though quartz and pyrites may be present.

Such occurrences suggest that an ore-forming solution may and does precipitate more than one mineral simultaneously. Any one mineral will precipitate out as long as the feeding solutions contain its constituents and as long as the equilibrium changes, brought about by various factors, at the locus of deposition are sufficient to depress its solubility below its concentration in the solution. Of two minerals forming at the same time one will usually have a more pronounced tendency to assume its own crystal shape, thus giving a false impression as to their relative ages. Moreover, it is the order of completion of crystallization rather than the beginning which determines the apparent relations between two associated minerals.

In every specimen in which tourmaline or topaz were present they were distinctly the first minerals introduced. Pyrite and arsenopyrite are the earliest of the common ore minerals and are always seen in well-defined crystals wherever they occur in this relation. Where banding or crustification are present they occur abundantly in the earliest bands. The solutions, however, were not always exhausted in these constituents in an early stage, for in one specimen pyrite with stannite and sphalerite is distinctly later than cylindrite, and Dr. L. J. Spencer describes a specimen consisting of an aggregate of jamesonite needles encrusted with small crystals of pyrite and stannite. This latter relation, however, is so contradictory to all occurrences seen by the writer that it is felt to be entirely exceptional, due to some unusual repetiton of solutions.

Quartz always appears a little later than the earliest generation of pyrite and is usually very closely followed by cassiterite, which moulds about the quartz crystals, but assumes crystalline shapes on the walls of cavities.

In those ores which contain bismuth and its sulphide, bismuthinite, these minerals and cassiterite often seem nearly the same age, though an occasional specimen shows bismuthinite in layers surrounding native bismuth.

In the cylindrite and franckeite ores examined, these minerals were invariably earlier than any associated minerals except quartz and cassiterite. Hintze, in his mineralogy, quotes Frenzel as describing cylindrite grouped upon tetrahedrite ore from the Mina Pizarra at Oruro, but it is not clear whether he intends to give the impression that the tetrahedrite is the earlier.

Stannite is present more or less abundantly in all the complex tin ores, and is most commonly associated with tetrahedrite and with sphalerite and chalcopyrite. It is practically contemporaneous with the latter two, often occurring in very fine grained mixtures. The relation between the stannite and tetrahedrite is not always clear in the massive ores, but after studying some twenty different ores containing these minerals, the author has come to the conclusion that stannite is usually the earlier. It commonly appears filling angles between the older minerals, all being surrounded by tetrahedrite, consistently giving the impression that the stannite areas are residual. Many specimens of massive ore show the two minerals apparently contemporaneous, but the author has failed to find any case in which stannite is later than tetrahedrite. However, Spencer has described a specimen from the Socavon de la Virgen at Oruro which consists of a group of bright tetrahedrite crystals on a matrix of massive pyrite. Stannite crystals are plentifully scattered over the tetrahedrite, in the surface of which they are partly embedded. Thus it is seen that, though the majority of cases show the stannite slightly earlier than the tetrahedrite, their periods of deposition distinctly overlap and even the reverse of the common relation occurs.

Jamesonite, which is abundant in many of the sulphide ores, was observed in every case to be the last hypogene mineral formed, with the exception of pyrargyrite or proustite, which, though often supergene, are sometimes probably of late hypogene origin. The jamesonite needles encrust cavities in massive ores consisting of all the earlier minerals, including stannite and tetrahedrite. Its late origin is so clear cut in every instance that the case, described by Spencer, of jamesonite needles encrusted with pyrite and stannite requires an exceptional explanation. The gap to be bridged by an overlap in the periods of mineralization in this instance is too great and no attempt is made to fit the case into the normal sequence.

THE PAS MINING DISTRICT, MANITOBA.

The *Canadian Mining Journal* for October 22 contains an official report on The Pas mineral district in Northern Manitoba and its progress during the summer of 1920, written by R. C. Wallace, Commissioner of Northern Manitoba. As readers are aware, the ore deposits here are sulphides, in places massive, and with pyrite often predominating; at the east end, gold-quartz veins are found.

During the summer, development work has been confined mainly to the western and eastern ends of the district. There has, indeed, been considerable diamond-drilling in Copper Lake, north of Cranberry, and a good deal of interest in gold discoveries at the north end of Elbow Lake, situated to the north-east of Cranberry, as well as a larger amount of prospecting in the Reed Lake territory than during any previous summer. The fact remains, however, that the two pivotal points are the Flin-Flon ore-body in its importance to the copper-mining industry in the western part of the belt and to the mining industry in the eastern part of the belt. As far as copper development is concerned in particular, there has been a tendency to await the development of railway facilities consequent on the operation of the Flin-Flon property before any very considerable expenditure of capital is made on other copper properties in the western part of the belt.

From the work that has been done during the present summer by the Thompson interests, through the Longyear Exploration Company, it is now possible to study the Flin-Flon ore-body underground and to get a clearer conception of its relationships to the country rock than heretofore. The work which has now been done has exposed an ore-body in which the province of Manitoba will legitimately take considerable pride. In No. 1 (the south) shaft there has been 200 ft. of sinking, and in the beginning of September 210 ft. of cross-cut, as well as some hundred feet of southward drift. When the cross-cut has been completed to a width of 250 ft. there will be exposed over 100 ft. of solid sulphides, 30 ft. of high-grade disseminated copper ore, and some 90 ft. of low-grade disseminated. In No. 2 (the north) shaft the cross-cut has been run at the 100 ft. level to a length of 170 ft., entirely in ore with the exception of some 40 ft. of horse. Sinking is now proceeding to the 300 ft. level. The work already completed underground has been of great value, not only in checking up the diamond-drilling but particularly in determining the costs of mining and best method of development. There are undoubtedly many problems ahead which will attract the most skilful metallurgists before the best method of ore-treatment and smelting practice is determined for this complex ore-body.

There has been considerable activity in the district immediately north of the north arm of Lake Athapapuskow, the district which would seem to provide at the present time the best field for intensive prospecting in the whole belt. In a property held by Baker and Patton, in which the country rock is a quartz-porphyry striking north and dipping 80° east, an iron sulphide body has been developed on surface showing at least 130 ft. in width and bounded on one side by muskeg, in which there is a probability that the ore-body also will be found. Generally speaking, this iron deposit is similar to many others in the mineral belt. There is, however, for a width of 18 ft. in the centre of the body considerable copper mineralization, and in other places more limited copper pyrite. The surface showings of copper are sufficiently important to warrant expenditure on diamond drilling in order to determine the extent of the copper mineralization underground. It is understood that there are other showings of copper sulphide of somewhat similar type in this area. A discovery during the summer, interesting from a mineralogical point of view, was that made by Rosen, east of the Big Island Lake district. At the contact between granite and greenstone there has developed considerable mineralization of cobalt minerals, particularly smaltite in very fine grains weathering into cobalt bloom. Associated with this, and more particularly in a trench seventy-five paces to the east, chalcopyrite mineralization is found in the greenstone and also in the granite. The occurrence of cobalt minerals is an interesting one in the district and seems, judging by other work in the mineral belt, to be fairly wide-spread. The importance of cobalt minerals and the cobalt bloom stain in the Cobalt country in Ontario has been the close association of cobalt minerals, in narrow calcite veins, with native silver and silver sulphides. Unless the geological conditions are similar there is no necessary connection in this field between cobalt minerals and native silver. If, however, a late diabase and associated narrow calcite veins can be found in this territory, it should be considered to be a favourable prospecting ground for silver.

At Copper and Elbow Lakes, in the central part of the district, diamond-drilling proceeded during the summer months upon the large quartz property of J. P. Gordon, of Copper Lake. It is understood that the diamond-drilling showed the quartz to be associated underground with considerable porphyry, and that mineralization with iron sulphides was found in a heavier degree than on surface showings. No further work has been done on the Red Rose vein of high-grade ore. Work is now proceeding on some claims east of Bear Lake immediately north of the Third Cranberry, in which stringers of chalcopyrite are found in a fairly solid greenstone and more particularly in quartz-porphyry intrusions into the greenstone rock. The quartz-porphyry holds a clean ore, which, if developed in sufficient quantity, will readily concentrate. At the north end of Elbow Lake considerable prospecting was done during the earlier part of the summer, owing to the fact that discoveries were made by Webb of high-grade quartz veins on the Sherlock claim, immediately west of the mouth of Webb Creek. The quartz is irregularly distributed through a twisted hornblende schist, and at the present time a showing about 1 ft. in width of highly quartzitic rock is being mined and hand-crushed in order to recover the gold by sluicing. In the same property several exposures of quartz, one at least 4 ft. in width, occur, the value of which has not yet been determined. Interest has also been taken in other properties at the east end of an island in the north part of Elbow Lake. The Bow vein was staked in greenstone schist, and as its name implies, is characterized by reduplicated folding. The average is probably 15 in.; the vein in places is 30 in. thick. This vein has been found, on careful sampling, to give high gold values. Immediately east of this vein, and parallel to it, is an intrusion of quartz-porphyry varying in width from 4 to 12 ft., and extending over the greater part of two claims. This porphyry is mineralized with pyrite and a little galena and is criss-crossed with narrow quartz veins. It would appear to be a rock of a type which might prove of value for fluxing purposes.

Considerable prospecting was done in the Reed Lake district this year, but the men in the eastern end of the belt confined their attention mainly to the working of properties in the Herb Lake and Little Herb Lake areas. An interesting discovery was made north of Little Herb River, at the right-angle bend, by R. Kerr and P. Gasse in a rock which is an altered sediment, and which varies in composition from a typical mica schist to a quartzite. Considerable galena has been deposited by replacement apparently from a granite, contact of which with the sediment is immediately west of the main discovery. Associated with the galena is pyrite, a little pyrrhotite, and arsenical iron, and here and there stibnite in considerable quantity. From the trenching which has been done it would seem that the mineralization has taken place in more or less parallel bands which strike about 30° west of the schistosity of the rock. In the main trench, for a distance of 15 ft. there is heavy mineralization, mainly of galena, partly of pyrite, and to a slight extent of pyrrhotite and stibnite. The importance of the discovery is that the galena carries high values in silver. It is interesting that north-west of Osborne Lake galena has also been found in a similar rock type by J. Kerr, while east of the main discovery galena is found by P. Kobar and stibnite by E. Stewart. It would thus appear that the mineralization is fairly extensive, and much surface trenching and particularly diamond-drilling will undoubtedly be carried on in this district in order to determine the extent of the silver values. This is a new type of mineralization in the belt, and adds one more to the possibilities of economic development of a belt which is remarkably many-sided in its mineral types. During the past year R. Woosey and others have prospected the north-west end of Herb Lake. On an island immediately south of Woosey's Island a heavy mineralized basic rock shows iron and copper sulphides over a width of 5 ft. from the top of the cliff to the lake shore. The rock, which is rather unusual for the district, is of a type in which a basic segregation of sulphides is possible, and the occurrence has particular interest for that reason. On the east side of Herb Lake, the Rex gold mine and the Bingo property have been responsible for the development work during the summer. On the Rex mine work is now proceeding to develop the mine to the 300 ft. level, and at the same time to stope from the 100 ft. level in order to supply the mill, which is now operating. It will now be possible to stope over 150 ft. in the south drift with an average width of 3 ft., and 70 ft on the north drift with an average width of 2½ ft., at the same time as sinking is continuing to the 300 ft. level. When there is sufficient labour available to run the mill to capacity, the clean-up from those remarkably large stopes should be sufficient to place the property on a good footing for subsequent development on a much larger scale. At the Bingo property sinking has been completed to 50 ft., the vein averaging to this depth approximately 8 in., with at the bottom some quartz coming in, which will increase the average width by perhaps 2 in. A contract has now been taken to sink to the 300 ft. level and to do trenching and cross-cutting. The assay-values obtained to the depth at which the shaft has developed the vein are very high. To many observers of the situation in the eastern part of the mining field, it has been clear for some time that the advisable procedure would be to consolidate several properties on the east side of Herb Lake, making the Rex the centre of operations, and conveying ore by an air-line from the other properties to the Rex. If a strong mining corporation could succeed in effecting such a consolidation, the future for the Herb Lake district would be very good. The vein at the present time developed on the Rex mine is such as should attract a strong corporation, provided that a sufficiently large number of other properties could be consolidated with the Rex, in order that practically all the capital expenditure on mining machinery could be concentrated on the one property.

THE PORT PIRIE POWER PLANT.

Chemical Engineering and Mining Review (Melbourne) for September contains a description of the new power plant of the Broken Hill Associated Smelters, at Port Pirie, South Australia.

The plant is housed in a commodious building of three bays. The main engine and economizer room is of brick, and the boiler room steel-framed and of corrugated iron. The main engine room floor stands 17 ft. above the basement and carries two 3,000 k.w. turbo alternator sets, one 250 k.w. turbo alternator set, two 65 k.w. separate exciter sets, two Fraser & Chalmers Rateau blowers, each 32,000 cu. ft. of free air per minute at 5 lb. pressure, one Parsons turbo blower 36,000 cu. ft. of free air per minute at 4 lb. pressure, two Belliss & Morcom motor-driven compound air-compressors, each 1,200 cu. ft. free air per minute at 100 lb. pressure. In addition to these there are three main switchboard panels and 68 remote control panels and switches. The two 3,000 k.w. sets are duplicates, each consisting of a Fraser & Chalmers steam turbine of the Rateau type, designed for steam at 200 lb. pressure, direct coupled, with a flexible coupling, to a Vickers 3,000 k w. 575 volts 3-phase 50 cycle alternator, the speed of the set being 3,000 r.p.m. The turbine governor is controlled through oil relays, with an emergency governor which comes into operation if the machine should exceed a pre determined speed. All bearings are lubricated by oil under pressure, each bearing being provided with thermometers. Oil is pumped from the reservoir in the base, then through the bearings, finally through an oil cooler and back to the reservoir. Air passing through the alternator is first cooled and filtered by being drawn through a Sturtevant spray filter, located in the basement. The condensing plant for each 3,000 k.w. set consists of a Worthington surface condenser with 18 in. Weymouth circulating pump driven by 50 h.p. G.E. motor running at 530 r p.m., the air and condensate pumps being direct-coupled to a 30 h p. G.E. motor running at 1,450 r p.m. The air filters are supplied with water by means of a 2 in pump driven by a 3½ h.p. Vickers direct-current motor supplied from the exciters. One of the air filters was supplied by Fraser & Chalmers, and the other was made in the workshop at the smelters. The 250 k.w. set consists of a Parsons turbine direct connected to a Parsons alternator with direct-coupled exciter. It is provided with an Allen condenser with a 10 in. Weymouth motor-driven circulating pump and a three-throw vertical Allen air pump, Edwards type, gear-driven by a 7½ h.p. G.E. motor. Of the separate exciters one set is a 65 k.w. 130 volt British Thomson-Houston direct-current generator direct-coupled to a British Westinghouse 100 k.v.a. synchronous motor, and also to a 130 h.p. Terry steam turbine. The second set is a B.T.H. 65 k.w. generator direct-coupled to a B.T.H. synchronous motor rated at 94 k.v.a.

The Fraser & Chalmers blowers are equipped with Worthington surface condensers, Weymouth 10 in. centrifugal circulating pumps direct-coupled to 20 h.p. General Electric motors at 725 r.p.m., and Worthington two crank vertical air pumps, gear-driven by 7 h.p. Phœnix motors. The condensing equipment for the Parsons turbo blower consists of an Allen condenser, Weymouth 10 in. centrifugal circulating pump, direct-connected to a 20 h.p. General Electric motor, and an Allen three throw vertical air-pump, gear-driven by a 7½ h.p General Electric motor. In order to minimize the chance of passing quantities of dust through the blowers with the incoming air, the inlets to the suction pipes are situated at the top of a set of towers. The discharge from each blower passes through a hand-operated gate-valve, an automatic non-return and relief valve, and thence through a butterfly valve to the 43 in. mains, which convey the blast to the smelter furnaces.

The air-compressors are in duplicate, and they are Belliss & Morcom vertical two-stage two-crank machines, capable of delivering 1,200 cu. ft. of free air per minute when running at 300 r.p.m. Each machine is direct-coupled to a 250 h.p. B.T.H. motor. The inlet air passes through a dry air filter; while the discharge is carried to a large receiver outside the plant, and thence to subsidiary receivers in various parts of the works.

The main switchboard, which is in the engine-room and situated immediately over the switch room, consists of: three generator panels, each of 5,000 amp. capacity; five 2,000 amp. main feeder panels; four sub-feeder panels (500 amp.); one Tirrill regulating panel; two synchronous motor panels; three exciter panels. The fireproof switch-room is situated in the basement below the main switchboard, and contains the whole of the main busbars, oil switches, and generator field rheostats. Current at a pressure of 575 volts is conducted to the generator-switches by conductors consisting of three bars, each 8 in. by ¼ in. copper-strip on each phase. The closing and opening operations of the oil switches are effected by means of solenoids operated from the exciter busbars, and controlled by pull-button on the main switchboard, the closed and open positions being indicated by both mechanical and electrical signals. The main break is in air, the final break by auxiliary contact, occurring a fraction of a second later in oil, each leg being in a separate oil-tank. The closing coils, of which there are two, take about

35 amperes at 100 volts. The opening coil operates on a toggle, and takes about 9 amperes. The busbars consist of three 10 in. by $\frac{1}{4}$ in. copper bars in parallel on each leg. From the busbars the current passes through six 4,500 volt General Electric K12 2,000 amp. switches, which control the outgoing feeders, the control being the same as for the main switches. The opening coils of these switches are operated automatically by selective time-limit overload relays on the main switchboard. The current transformers for the switchboard are of the slip-over type, no mechanical connections to the main being required. All motors throughout the works are controlled from the power plant. The motor control board, which runs almost the entire length of the engine room on the south side, is constructed on the common compensator system. Every motor in the works is equipped with a small push-button signal panel. The pressing of the button at the motor actuates a relay which operates a signal hooter at the power plant, at the same time operating a drop-shutter which lights a lamp over the panel belonging to the motor which is to be started. Each panel is equipped with an indicating light drop-shutter, ammeter, and switch, automatic oil switch, and three-pole knife switch. The starting system consists of a set of three starting-bars and three running-bars, the knife-switch and compensator being connected to the starting-bars, and the oil switches to the running-bars. The running-bars can be isolated into three sections, and have a double set of feeders. To start up any motor, the knife-switch is closed and the motor started from the compensator. The oil switch is then closed in and the knife-switch opened, releasing the compensator to the open position, and leaving it free to start any other motor. As each motor panel has its own ammeter and a small card giving the size of the motor, the control-board operator can see at any time whether any motor is overloaded or operating under abnormal conditions. An emergency switch is located close to every motor in the works, which can be opened in case of emergency.

The pump room is situated in the boiler room basement, and contains the following equipment: Two Weir's cross-compound vertical-boiler feed-pumps with steam cylinders 12 in. and 22 in. by $24\frac{1}{2}$ in. stroke; two 24 in. Weymouth centrifugal pumps for pumping to circulating water duct, each direct-coupled to a 125 h.p. General Electric motor; one 18 in. Weymouth centrifugal pump for pumping to circulating water duct, direct-coupled to a 50 h.p. General Electric motor; one 14 in. Kelly & Lewis centrifugal pump for the works general salt-water service, direct driven by a 100 h.p. General Electric motor; one 14 in. Kelly & Lewis centrifugal pump for the works general salt-water service, connected up for direct drive by either a 100 h.p. General Electric motor or a 130 h.p. Terry turbine (all on the same shaft); one Robison Bros. three-throw vertical hydraulic service pump, gear-driven by a 50 h.p. General Electric motor; one Worthington three-throw horizontal hydraulic service pump, gear-driven by a 35 h.p. General Electric motor; with Weymouth two stage 6 in. centrifugal fire service pump, direct connected to a 58 h.p. Terry turbine. The circulating water duct runs round the basement of the plant, and the various condenser circulating pumps draw their supply from the incoming side of the duct, and deliver the water through the condensers, discharging into the outlet side. The duct pumps draw their supply from the river and pump straight into the duct. The general-service pumps and the fire pump can draw from either duct or river. The turbine-driven fire-service pump is always kept primed, with the turbine warmed up, and the drains open, and can be started up in 30 seconds at any time. One of the general-service pumps has both motor and turbine drive, so that in the event of a total breakdown on the electrical side, the pump can be driven by the turbine, thus ensuring a supply of salt water to the works for the smelter-furnace jackets and other necessary purposes. The hydraulic service is used primarily for lifts and traversers, and is operated at 400 lb. pressure.

The boilers are on an elevation of about 14 ft. from the basement or ground floor. There are six boilers, all of the Babcock & Wilcox W.I.F. type, with double drums, superheaters, and chain-grate stokers. The stokers are driven from a shaft running the entire length of the boiler room, and immediately over the furnaces. The shaft is motor-driven at one end; at the other end there is a $4\frac{3}{4}$ in. and $8\frac{1}{2}$ in. by 5 in. Belliss & Morcom tandem compound vertical engine. This engine is always kept warmed up, the drains open, and the driving belt hung on brackets. In the event of a breakdown on the motor drive the engine can be started up and connected to the stoker shaft in a few seconds. Each boiler has 252 4-in. tubes and a total heating surface of 5,540 sq. ft., the commercial rating being about 1,200 h.p. per boiler. The working pressure is 200 lb. per sq. in., with about 130° superheat. The flue gases pass through three sets of Green's economizers, each of 400 tubes, and thence through a ground flue and fans to the chimney stacks. A large exhaust fan, direct-connected to an 11 in. and 18 in. by 9 in. cross-compound Belliss & Morcom engine, is arranged at the base of each stack. The feed-water is handled as follows: The condensate from the various condensers is carried to a large concrete tank in the basement. It is lifted from this tank by means of an ejector into the measuring tank of a Lea V-notch recording-set. All the necessary make-up water is also delivered into this tank, so that the whole of the boiler feed-water is registered by the Lea recorder. The indicating and recording mechanism of the Lea recorder is in the engine room. From the recorder the feed-water runs into the pump-suction tank, from which it has a fall of about 8 ft. to the feed pumps, which are of the Weir type, arranged to deliver the feed-water direct to the boilers or through the economizers. The main steam header, of 12 in. steel pipe, is in the boiler room close to and parallel with the engine-room wall, and runs the full length of the engine-room, with a large expansion bend in the centre. Each boiler is connected separately to the header by a 7 in. steel pipe. The whole system is divided into three sections, which may be isolated from each other if necessary. A gangway gallery runs the full length of the header, giving easy access for the purpose of opening and closing valves and drains or effecting repairs. Each unit in the engine-room has its own separate feeder from the main header; the pipes are taken downward from the header, through the basement, and up through the engine-room floor. This simplifies the problem of draining the pipes, and does away with all overhead pipes in the engine room, thus giving a free, unimpeded run for the overhead crane. Steam traps are fixed at intervals along the main header, and the whole system is lagged with Foster's steam-pipe covering.

A large storage space, capable of accommodating 3,000 or 4,000 tons of coal, is arranged near the plant. A concrete tunnel, equipped with a belt conveyor, is constructed under this storage heap. There are numerous doors and chutes in the roof of the tunnel, through any one of which the coal can be run down on to the conveyor belt. This discharges it into the hopper of a vertical bucket elevator. The coal is elevated to another conveyor, which runs over the six bunkers and discharges its load into any one of them by means of a movable tripper. Chutes feed the stoker hoppers of the boilers as required. When coal is received from a ship, it is delivered into railway trucks at the wharf and conveyed to the power plant. The receiving hopper of the elevator before referred to is constructed so that the coal passes direct to the elevator buckets, or through a Jeffrey coal-crusher, and then to the elevator. The coal is discharged into the elevator hopper, and is delivered into the bunkers over the boilers. When the bunkers are full, the coal is deflected into a series of chutes which deliver it on to the storage heap outside the plant. As the bunker conveyor belt is 60 ft. above the ground, it forms an excellent means of building up a large storage heap, which can be utilized at any time by means of the tunnel-conveyor system. It is intended later to extend the company's wharf to the power plant, so that steamers can discharge direct to the storage heap. For handling ashes, soot, and flue dust, side tipping trucks are used. These are run out, and the ashes, etc., are tipped into an elevator hopper, which discharges them into a large overhead storage bin. Railway trucks run under this bin and take the ashes away as required. Each of the various conveyors and elevators in connection with coal and ash handling is driven by a separate motor, the reduction in some cases being effected by countershafts and belt drive, and in other cases by means of Richardson worm gears.

A number of minor details of equipment around the plant have yet to be completed. Owing to the difficulty in obtaining delivery of plant, it has been impossible to complete all these. Evaporators are to be installed in the pump room to supply all the make-up water required for the boiler feed, also an automatic Dennison weigher, which is to be attached to the belt conveyor over the coal storage bins. A Sarco CO_2 recorder forms part of the equipment of the boiler room. The two large alternator sets and the two Fraser & Chalmers turbo blowers are also equipped with General Electric Co.'s steam-flow meters, and the condensers are connected to Brady & Martin kentometers. Bristol recording pressure-gauges are also arranged in the blast delivery mains from each of the turbo blowers. In order to guard against the plant being in total darkness in the event of a sudden breakdown, a small battery of accumulators, which supplies current to a separate special low-voltage lighting circuit in the engine room and boiler room, has been supplied. These cells, which are charged from the exciter busbars, are merely a temporary source of light, as in the event of a stoppage of the alternators the ordinary lighting circuit can be supplied by means of a change-over switch with direct current from the turbine-driven exciter set, through the direct-current busbars. The smelter power-plant also supplies current for lighting and power to the town of Port Pirie. Current at 575 volts is taken from the switchboard and is stepped-up to 6,900 volts by means of General Electric oil-cooled transformers. This current is transmitted to the sub-station in the town, where it passes through the step-down transformers, the town supply being 220 volts for both light and power.

Asbestos in Australia.—The *Queensland Government Mining Journal* for September contains an article by B. Dunstan, Chief Government Geologist, on asbestos. We extract the following notes relating to occurrences in Australia, beginning with those in Queensland. The Cawarral-Canoona serpentine belt is a large area of country to the north-east and north of Rockhampton, extending from Balnagowan near the Fitzroy river to Marlborough in the direction of Broadsound. This area contains asbestos deposits in a number of localities, and records have been made of their occurrence at Broadmount, Tungamull, Mount Wheeler, Mount Etna, Morinish, Princhester, Mount Fairview at Canoona, Clifton Station near Marlborough, and Dalcalmah near Glen Geddes railway station. Asbestos is also found in serpentine in the Kilkivan district at Mount Muir and Black Snake, in the Kandanga district near the Blue Bell copper mine near Wodonga Creek to the south-south-west of Gympie, at Yarrol on the Burnett river, at Calliope near Gladstone, and at Eddystone to the north of Mitchell in the Maranoa district. At Mount Pring, close to Bowen, a serpentine area has been recently prospected showing the presence of asbestos in small quantities, and a deposit between Petford and Fossilbrook on one of the branches of the Tate river has lately been opened up. The deposits at Princhester and Marlborough appear to be those of most importance, although as a matter of fact very little is known of the value or extent of any of them. About nine miles to the north-north-east of Princhester, which is only an old township site, the asbestos has been found in mountainous country north of Paddock Creek, a branch of Tilpal Creek, about four miles from the railway now under construction between Rockhampton and St. Lawrence. Some years ago mining operations in this locality revealed numerous veins of soft asbestos along a face 20 ft. wide, but the thick overburden evidently discouraged the prospectors, and the work was abandoned. From a personal interview with one who worked in the mine, and from the fact that £25 per ton was offered for the product, it would appear that the deposit is of an encouraging character and that it should have further work expended upon it. Twelve or thirteen miles south-south-east of Marlborough asbestos veins occur in the area bounded by Delvin and Marlborough Creeks and the Fitzroy river, those on Marlborough Creek near its junction with the Fitzroy river containing veins said to be numerous, silky, clearly defined, and with the fibre 1½ in. long. A few miles from Princhester railway station other deposits exist, and the serpentine country to the north of the township is known to contain veins of asbestos of varying quality. At Dalcalmah near Glen Geddes railway station, near Marlborough, a deposit of some importance has been revealed, and as the asbestos is in demand for numerous purposes the discovery is worthy of attention. Asbestos deposits also occur about two miles from the Ayr-Bowen tramline and about twelve miles by road from Bowen, the mineral being exposed on one of the steel spurs on the south-western side of Mount Pring.

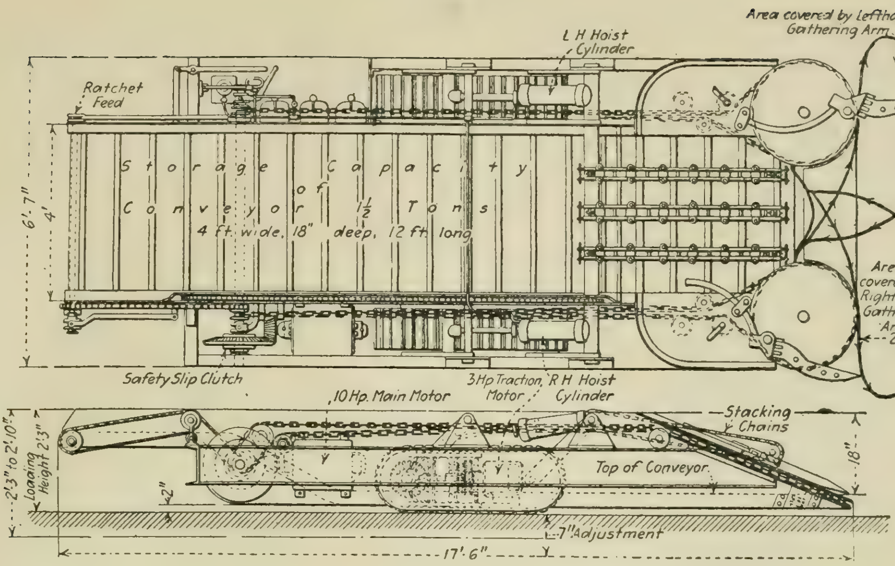
In New South Wales deposits of asbestos have been worked at Gundagai, but trials made of the product have not resulted in their development. During the two last years asbestos has been worked at Barraba in New England, and the results of trials have been so satisfactory that developments in a large way are contemplated. At Woodsreef in the same district another deposit has been opened. Asbestos has been found in many localities in South Australia, but does not seem to have been successfully mined, although discoveries of crocidolite in limestone have been made at Robertstown, and of chrysotile asbestos at Minbrie near Cowell, tests of which were considered very satisfactory. Tasmania produced inferior asbestos many years ago, but the industry made no progress. Recently, however, the Anderson's Creek deposits near Beaconsfield have been re-opened and the product is now being utilized in the manufacture of cement-asbestos slates and sheets. Reports from West Australia have drawn attention to asbestos at Soanesville on the Pilbara goldfield, where two lodes have been exposed, the fibre being short but of fine quality.

The Anderson Creek deposits in Tasmania are in serpentine flanked by what appears to be a sedimentary rock, while those at Pilbara in West Australia are in serpentine which is said to be an altered peridotite. This rock intrudes an adjacent sedimentary formation and is itself intruded by several dolerite dykes. The deposits about Rockhampton are in serpentine in the vicinity of basic intrusions, similar conditions prevailing in several other localities in Queensland where the serpentines contain asbestos. At Barraba, in New South Wales, the asbestos is in the form of veins about one inch thick and occurs in a belt of serpentine, the veins being numerous and fairly close to one another. Up to the present time this deposit appears to be the most successful one opened up in New South Wales and produces a fibre superior to anything yet found in Queensland. The Minbrie asbestos deposit in South Australia is in association with serpentine, marble, &c., the rocks containing about ½% of crude hand-picked fibre with about 15 or 20% of milling rock.

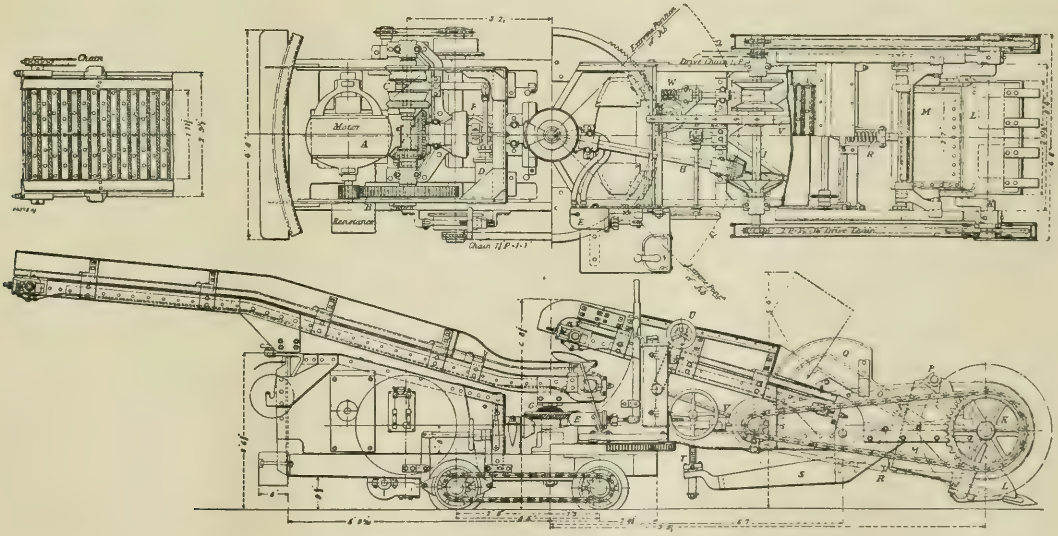
Mercury in Power Plant.—In the issue of *Power* (New York) for October 27, W. L. R. Emmet describes his method of using mercury vapour as a medium for producing power in a boiler-furnace. He uses mercury vapour in a turbine, and employs the heat absorbed in condensing the vapour in a steam turbine. Mercury boils and condenses like water, but both its density and its boiling temperature are much higher. Thus at atmospheric pressure mercury boils at 677° F. and condenses in a 28 in. vacuum at 455° F., while the corresponding temperatures for water are 212° and 101°F. According to Mr. Emmet's scheme, mercury is boiled in a boiler similar in principle to, but differing greatly in detail from, an ordinary steam boiler, and the mercury vapour produced is used to run a turbine. The exhaust from the mercury turbine is condensed in a form of surface condenser, which is also a boiler. The heat given out by the condensing mercury vapour makes steam of the cooling water, and this steam may be used to drive another turbine or for any other purpose. The chief difficulties arise from the large amount of mercury required and the possibility of leaks. In Mr. Emmet's apparatus, the products of combustion from the furnace pass upward through part of the tubes which form the heating surface of the mercury boiler, and then forward among the remainder. These tubes are connected to the lower mercury chest which is in the position of a mud drum of a steam boiler, and to the mercury header, which corresponds to the steam drum in an ordinary boiler. Mercury vapour at about 10 lb. gauge pressure is collected in the header and passes through the pipe to the mercury turbine. Owing to the high density and low spouting velocity of the mercury vapour this turbine may be a single-stage machine, of reasonably low speed, and may have short buckets. The wheel may be placed inside the mercury condenser for simplicity. The mercury condenser consists of a tank, which supports another tank which is a steam drum. A number of straight tubes extend from the bottom of the steam drum down into the condenser. The exhaust from the mercury condenser is condensed upon the surface of these tubes, and as the boiling-point of the mercury at 28 in. vacuum is 455° F., steam is generated in these tubes. Circulation in the tubes is provided by smaller interior tubes leading from the steam drum, which corresponds to the upper drum of a water-tube boiler. Steam generated in this condenser boiler is led through a pipe to the superheater and thence to the steam main, which conveys it to the point where the steam is to be used. The mercury condensate is drained from the bottom of the mercury condenser to the lower mercury header and thence to the mercury boiler. The high density of mercury renders a feed pump unnecessary, as by setting the condenser above the boiler the latter can be fed by gravity. The article contains a discussion of the thermodynamics of this new steam-raising apparatus. Mr. Emmet claims that by the addition of this device to a modern power station, with an increase of 15% in the amount of fuel used, the same amount of steam can be supplied to the steam turbine as under present conditions, and the mercury turbine will generate power equal to about 66% of the power generated by the steam turbine. The estimated result is a gain in station capacity of approximately 66%, with an increase of only 15% in the amount of fuel required.

Mechanical Loaders.—Two mechanical loaders for use in mines were illustrated in the *Coal Age* for May 6 last. Labour-saving devices of this nature are used in America and are in demand elsewhere. The Joy machine, which is made by the Joy Machine Co., of Union Arcade Building, Pittsburgh, works on a new principle, in that it employs appliances like human arms to collect the broken coal or ore and draw it on to the conveyor. The illustration shows a low type such as is suitable for use in narrow seams or flat lodes. The machine contains two conveyors. One of these reaches from the gathering mechanism to a storage hopper that constitutes the body of the machine. The second is used to discharge the coal from the hopper into the mine car, which is placed to the rear of the machine. Both conveyors are flexibly mounted on the supporting truck and may be swung to nearly any angle. This feature of construction permits the machine to traverse short-radius curves. The gathering mechanism is placed at the forward end of the loading conveyor. It consists of a pair of geared fingers which are arranged so as to be positively driven in a fixed orbital path. The initial movement of the fingers is forward into the coal, after which there is a raking motion across the coal face, and then a rearward movement toward the loading conveyor. From this point the movement is a return to the starting position. The path of the finger tips is shown in the drawing. After the machine has been brought to the face where it is desired to load, the loading conveyor is lowered so as to bring the gathering mechanism at the front end into contact with the floor. The machine is then propelled forward until the gathering mechanism is in close proximity to the loosened material, after which it is set in motion and the machine bodily moved forward on the track until the fingers in their orbital movement engage the coal and gather it on to the loading conveyor. The gathering mechanism is of simple but rugged construction, and with its undermining action is capable of loosening the material from a semi-undisturbed state. Safety measures in the form of friction clutches are provided so as to prevent destruction of the gathering mechanism when the fingers encounter relatively immovable pieces. The storage hopper goes a long way in solving the transport problem, since it makes possible the changing of cars without interrupting the operation of gathering the coal from the floor.

The other machine described is that invented by William Whaley, of Knoxville, Tennessee, and made by the Myers-Whaley Co., of that town. The firm has a representative at 63, Queen Victoria Street, London, E.C 4. This machine is already fairly well known, but for the benefit of those who are not familiar with it an illustration is given herewith. The machine is equipped with an automatic shovel supported and



THE JOY MECHANICAL LOADER.



THE MYERS-WHALEY SHOVELLING MACHINE.

driven by a crank. The shovel discharges on to the forward conveyor, which delivers its load to the rear conveyor, which in turn discharges into the mine car. The shovel and front conveyor are mounted on a swinging jib, enabling the machine to shovel at a distance of 8 to 10 ft. to each side of the track centre. The rear conveyor also swings laterally so that it can load cars on curves or upon a parallel track. The jib and rear conveyor are pivoted upon a main frame carrying the motor and propelling mechanism. This main frame is supported by four track wheels solid on their axles and mounted in adjusting pedestal boxes to allow for any inequalities of the track. The machine is moved forward and backward under its own power and uses no jacks or clamps. It is as portable as a mine locomotive, and travels readily from place to place. The operator is provided with a seat on the jib where he can see and direct the shovel to its work.

South African Iron and Steel.—The *South African Journal of Industries* has been publishing a series of articles by Professor G. H. Stanley on the production of iron and steel in South Africa and the prospects of an industry founded on African iron ores. In the last of the series, appearing in the October issue, he gives a general résumé of the present position. As yet there has been scarcely more than experimental production of iron or steel from ore in the country, but rapid developments are in progress and it is anticipated that production on a considerable scale will not be long delayed. Nearly all the plants at present operating are using imported pig iron and, to a much greater extent, locally-produced scrap metal, either iron or steel.

The chief, and almost the only, users of cast iron are the numerous foundries, and for the usual foundry purposes On the Witwatersrand at least, and probably elsewhere, since scrap cast iron has been in the past relatively cheap and plentiful, three or four times as much scrap as pig has been used, and during the war this has tended to increase as more work has been done locally and pig became more and more scarce and costly. At the present time it is almost as difficult to procure scrap as pig, and foundries would undoubtedly welcome cheap pig iron. Besides private concerns, a few of the mines have their own foundries. Estimates of the requirement of pig on the Witwatersrand for foundry purposes have varied from 150 to 700 tons per month, and it appears quite probable that at a reasonably low price the latter figure would not be excessive. Practically all classes of work can be turned out, and since the war began castings up to seven tons in weight have been made. Elsewhere, the various railway workshops have foundries, as also have some of the diamond mines, and there are private concerns operating at Capetown, Durban, and other coast towns. None of them are very large, and they cater of course for their local markets, the cost of pig, of labour, and of fuel operating adversely against large outputs, although a very large tonnage of castings is imported. Should it become possible to obtain pig cheaply this of itself would imply a cheaper fuel supply, and by the installation of certain mechanical appliances, such as moulding machines, the cost of producing castings should be greatly reduced and result in correspondingly increased production.

The plant of the Union Steel Corporation, at Vereeniging, commenced operations in 1913, and after overcoming numerous initial difficulties now has installed two basic open-hearth furnaces of respectively 10 and 20 tons capacity, fired by gas from Witbank coal, that on the spot having been found unsuitable. The raw material is mainly scrap steel of various classes, largely from the railways and mines, together with some cast iron scrap and a small amount of pig iron. All the refractories employed are also produced at Vereeniging by the Vereeniging Brick and Tile Company, and comprise fire-clay, silica, and magnesite bricks, while magnesite is obtained from Malelane, and the chromite, lime, and fluor-spar employed is also obtained in the Transvaal. The plant is capable of turning out a variety of products, mainly light sections from ½ in. rod up to the size of 30 lb. rails, but steel castings are also made and have been produced up to 5 tons weight, while it would be possible to make considerably larger castings, even 8 to 10 tons. The metal, for various purposes, varies in character from very mild steel bars for blacksmith work to the hard steel bars used for Osborne tube-mill liners, but is chiefly medium-carbon steel for rails, flats, angles, channels, rounds, etc. The quality being satisfactory, the plant has been of great value to the country, and particularly to the mining industry, during the war, and the output has increased to over 1,000 tons per month. The employees number 117 white men, skilled and semi-skilled, and 253 coloured labourers. An electric furnace of the Heroult type, 3½ tons capacity, for final refining has recently been installed, and should enable the highest grade steel to be produced and at the same time lead to increased output, while it is expected that the consequent increased demand for raw material will be met by the establishment of blast-furnaces in the Union. This steel works, together with the power station of the Victoria Falls Company, the brick works, and flour mills already constitute Vereeniging an industrial centre, and the very favourable conditions with regard to fuel, water, and power supply should ensure its rapid growth.

Experimental smelting with a small blast-furnace was commenced by the Transvaal Blast Furnaces, Ltd., at Vereeniging in October, 1918, and, after various initial troubles had been overcome, a good pig iron was successfully produced from Transvaal ores with Natal coke. Having served its purpose, and in view of possible developments, the plant has been shut down.

The Dunswart Iron and Steel Co., Ltd., has a plant at Dunswart, near Benoni and Boksburg, at which suitable scrap, chiefly obtained from the mines, is heated in coal-fired mill furnaces and rolled to various sections, no actual melting being done. Large pieces such as stamp stems and cam shafts are rolled as such, smaller stuff being piled and hammered. The output is obviously limited by the supply of suitable scrap, and it is understood to be in contemplation to install melting furnaces, either gas-fired or electric or both. The capacity is about 450 tons per month, and the employees average about 40 white and 200 coloured labourers. At this works also the refractories used are local productions, obtained from the Boksburg Brick and Fireclay Company, and are probably the most refractory made in the Transvaal.

The plant of the Witwatersrand Co-operative Smelting Works was established last year on the Robinson gold mine in order to demonstrate the feasibility of preparing steel shoes and dies for stamp batteries by remelting those worn and discarded, and so to remedy to some extent the probable shortage due to the difficulty of importation in war time. It consists of Kjellin-type induction furnaces pouring about one short ton of metal per heat, and making four heats per day of twenty-four hours. There are two of these furnaces, one stationary, and one tilting. Electrical power is supplied by the Victoria Falls and Transvaal Power Company, and is transformed for the furnace by means of a rotary transformer-set of about 250 h.p. The metal is cast into iron moulds with sand tops, giving the shape required without forging. Operations were commenced in September, 1916, and the output has been gradually raised till nearly 100 tons per month of castings is obtained. The plant employs six whites and about thirty coloured. The capital cost was rather more than £5,000, and the cost of production (with scrap at £1 per ton) is about £14 per ton.

The Pretoria Iron Mines, Ltd., erected a small blast-furnace to produce about 10 tons per day, which was blown in on June 15, 1918. The materials used were ore from the Time-Ball Hill quartzites and clay-band mixed, coke from Natal, and limestone from Taungs or local cave deposits, while dolomite was also used with satisfactory results. The blast was provided by a steam-driven air-compressor, suitably modified and heated by means of a pipe stove on top of the furnace. Owing to the influenza epidemic rendering it impossible to carry on, the furnace was blown out in October, after producing about 600 tons of white, mottled, and grey iron. A very wet season interfered with brick-making, and the builders' strike caused further delay, so that it was not blown in again until March, 1919. This second campaign lasted six months and raised the total production to nearly 2,000 tons, when the furnace was again blown out to enable a foundry to be erected to work in conjunction with it. That having been completed, the furnace is now about to be blown in again. In the meantime it is understood that satisfactory financial arrangements have been made for the development of this concern into a modern plant of considerable size, capable of supplying a large proportion of the requirements of the country for iron and steel goods, such as rails, sections, fencing material, etc.

The Newcastle Iron and Steel Company, Ltd., has commenced the erection of a blast-furnace plant at Newcastle in Natal. The furnace is to be 14 ft. by 65 ft., provided with a blowing engine with air cylinders 70 by 60 in., supplied with steam from 1,200 h.p. boilers, which can be fired with coal dust when gas is not available. The output is expected to be about 100 to 120 tons per day, and the manufacture of cast iron pipes and other iron and steel castings is contemplated.

As regards the future, it has been proved that iron ore, fuel, and flux of satisfactory quality exist in the Union of South Africa, as do other raw materials required for the manufacture of iron and steel. A market to the extent of over 50,000 tons of iron and steel per annum is available in the interior, and the ore, fuel, and flux deposits are so situated that, while they do not occur together, they could be transported by rail without the cost being excessive. An industry of this magnitude will be bound to progress, as the uses and employment of iron and steel must continue to increase, and a production of 175,000 tons would be possible in the not very distant future. Further information is, however, required in some directions: (1) Additional localities where coking coal occurs, tonnage available, quality of coal and coke, and by-products obtainable therefrom; (2) occurrences of manganese ores, analyses of ores, and amounts available; (3) magnitude of certain known deposits of iron ore and in what manner the analysis varies from place to place; (4) possibility of commercial production of iron and steel from the immense deposits of titaniferous ore. These are stated in order of importance, and the investigations under the first two heads should be instituted as soon as possible; the others are also of great importance and should be undertaken without undue delay.

Mining in Narrow Veins.—The *South African Mining and Engineering Journal* for October 30 describes the method of stoping adopted at the Southern Van Ryn mine in the Heidelberg district, where the lodes dip steeply and are narrow and of low grade. The method is also said to have been adopted at the Randfontein. The method is, however, not new. Briefly, the system is a reversal of the method of resuing, and approximates very closely to the practice adopted in coal mining, where the seams are very thin. Instead of carrying a stope over the full working width, it is first of all mined from the hanging wall of the reef down to such a point as will include the top layer of shale, say from 3 in. to 6 in. of shale, as this usually carries considerable quantities of gold. The stope face is carried in for a distance of from 6 ft. to 10 ft. in the reef with the contact and a few inches of the foot-wall shale, only the clean ore being removed after blasting and sent direct from the mine to the surface for treatment at the reduction works. The second step necessary for the full stoping width which it has been decided to carry consists in breaking up so much of the shale foot-wall as will be found desirable. This is dealt with in the usual manner as a means of filling up the packs and stulls for the support of the hanging wall. When this second operation is completed stoping again proceeds on the clean ore, a further 6 ft. to 10 ft. of reef is broken and trammed away, and the waste once more dealt with and removed for packs. The advantages claimed for this method are: (1) It permits of a clean ore being mined; (2) it provides for a stoping width for narrow reefs which will enable low-grade reefs to become payable; (3) it dispenses with sorting both underground and on the surface and does away with expensive sorting plants at the mills; (4) it reduces the initial cost of surface equipment, since only such a plant as is sufficiently large to deal with the gold-bearing rock will be needed; (5) it provides for only such actual quantities of waste being mined as may be necessary for supporting the hanging wall in the mine when built into walls, packs, or stulls; (6) there is also a further saving in explosives, labour, and wear and tear of machinery and cost of power, since less waste rock is drilled over, blasted, and trammed. It is claimed that this method makes it possible to work low-grade narrow seams at a profit; it is clear, however, that it is not applicable where the lodes dip flatly.

Elmore's Process for Treating Argentiferous Sulphides.—In the MAGAZINE for August, September, and October, 1919, particulars were given of F. E. Elmore's process for treating zinc-lead sulphides, now being developed by the Chemical and Metallurgical Corporation. In a patent issued last month, 15,783 and 31,797 of 1919 (151 698), Mr. Elmore describes a modification suitable for treating such sulphides as are rich in silver. We quote part of the complete specification herewith.

In Complete Specification No. 127,641 [see the MAGAZINE for August, 1919] the inventor described a process (hereinafter called "the acid brine process") for the separation of lead and zinc from ores in which these metals co-exist in the form of sulphides, the said process consisting in treating the finely-divided ore with a hot strong solution of sodium chloride to which a sufficient quantity of sulphuric or hydrochloric acid or an alkali bisulphate is added, whereby the lead is caused to pass into solution, while substantially the whole of the zinc sulphide remains undissolved, the hot solution obtained being separated from the residue containing the undissolved zinc sulphide and cooled to cause a partial crystallization of the lead salt. Ores suitable for treatment by the aforesaid process frequently contain appreciable proportions of silver, the efficient recovery of which by hitherto known methods of extraction is attended with difficulties. On treatment of the ore with acid brine, only a portion of the silver passes into solution along with the lead. This portion may be recovered by known methods, but the balance remains undissolved with the zinc sulphide in the residue. The object of the present invention is to provide a satisfactory method of separating and recovering in form suitable for metallurgical treatment substantially the whole of the silver and also, if desired, the lead and zinc contained in such ores. In certain cases the ore may be poor in lead and zinc and yet rich enough in silver to be worth treatment for the recovery of this metal alone.

According to this invention the ore itself, or the argentiferous residue containing zinc sulphide obtained therefrom by the acid-brine process, is subjected to a suitable heat treatment as hereinafter described, and the silver and lead are then extracted by means of suitable solvents which leave the zinc sulphide substantially undissolved. In some cases the ore after heat-treatment is subjected to the acid-brine process, and the argentiferous zinc-sulphide residue obtained is then without further heat treatment leached by means of the said solvents. The silver passing into solution is recovered by known methods; the lead may also be recovered by known methods and the desilverized zinc sulphide may be subjected to metallurgical treatment as desired.

The suitable solvents aforesaid consist of hot strong solutions of sodium chloride, calcium chloride, or magnesium chloride containing relatively small proportions of hydrochloric acid, metallic chlorides of an acid nature, or both hydrochloric acid and such metallic chlorides. The inventor prefers to use a saturated solution of sodium chloride or a solution containing approximately 35% by weight of calcium chloride or magnesium chloride, to which has been added a small percentage (varying with the composition of the material to be leached) of cupric chloride, hydrochloric acid, or both. In cases where the ore after heat treatment is not subjected to the acid-brine process, he prefers to use a solvent containing about 35% of calcium or magnesium chloride and a quantity of hydrochloric acid not greatly in excess of that required to convert into lead chloride the lead in the material to be leached, after allowing for other acid-consuming constituents, if any, present in the ore. The formation of zinc chloride is thus reduced to a minimum, while satisfactory extractions of the silver and lead are effected.

The suitable heat treatment aforesaid consists, according to one form of the invention, in heating the ore or the argentiferous residue containing zinc sulphide to about a dull red heat (a temperature of about 500° to 600° C. being commonly suitable) in a closed or open vessel or in an atmosphere of neutral or reducing gas for a short period, for example, about one hour. This treatment greatly enhances the extractibility of the silver by the solvents aforesaid. Its effect does not appear to be dependent upon the oxidation of any of the sulphide of lead or zinc; satisfactory results have been obtained by the preferred method of heating the ore or argentiferous residue alone in a closed vessel, as well as by heating it in an open vessel, although in the latter case much of the lead sulphide and a relatively small portion of the zinc sulphide may become oxidized. The heating of the ore has also been carried out in presence of carbon dioxide, carbon monoxide, hydrogen and nitrogen, with satisfactory results, but he prefers the method of heating in the closed vessel. It has been observed that the beneficial effect of heat treatment upon the silver extraction is realized even if the ore be heated in presence of agents which cause much or the whole of the lead sulphide to become decomposed, or which at a suitable temperature cause more or less of the lead to be volatilized as chloride or oxychloride, the zinc sulphide in each case, however, remaining for the most part undecomposed. The heat treatment contemplated, therefore, is not confined to heating the ore by itself; it consists, according to a second form of the invention, in heating the ore in admixture with sodium chloride or other suitable halogen salt and in presence of air or other suitable oxidizing gas at any temperature from about 400° C. upward, provided the zinc sulphide remains for the most part undecomposed. In this form of the invention the solvent employed for extracting the silver from the argentiferous residue containing zinc sulphide which results from treating the ore in the aforesaid manner consists preferably of a hot, strong, acid solution of calcium or magnesium chloride containing about 35% of $CaCl_2$ or $MgCl_2$ and a relatively small quantity of hydrochloric acid preferably not greatly in excess of that required to ensure the extraction of the silver and lead present.

It is to be noted that it is essential to the invention that, when it is applied by first heating the ore in admixture with sodium chloride or other suitable halogen salt as aforesaid, this heating should be conducted under oxidizing conditions, and no broad claim is herein made for applying the invention by first subjecting the ore to a chloridizing heat treatment.

The inventor gives a number of specific examples of the application of the process. One of these may be quoted. An argentiferous lead-zinc sulphide ore from Burma is treated with hot strong brine and sulphuric acid in the manner indicated in Specification No. 127,641. There are thus obtained, on the one hand, an undissolved residue containing zinc sulphide and a portion of the silver, and, on the other, a hot solution containing the lead and the balance of the silver. The silver in the solution may be recovered by known methods; as the brine is in practice used repeatedly he prefers to cool the solution, collect the deposited lead salts, and treat the latter to concentrate and recover in the form of argentiferous lead sulphate the silver they contain, as described in Complete Specification No. 129,773. [See the MAGAZINE, September, 1919.] The argentiferous zinc sulphide residue, after draining, washing, and drying, is heated in a closed vessel to a dull red heat (about 600° C.) for about one hour, and is allowed to cool. It is then treated with a solvent consisting of a hot strong solution of calcium chloride containing about 35% of $CaCl_2$ and about 5% of cupric chloride, whereby substantially all the silver is extracted from the residue. Thus an argentiferous residue containing 18·6 oz. of silver per ton was leached for about one hour at 90° C. with the said solvent in the proportion of one gallon of liquid per pound of residue, 88% of the silver being extracted. A similar argentiferous residue, containing 23 oz. of silver per ton, when leached in the same manner with a solution containing 35% of calcium chloride, 5% of cupric chloride, and 3% of commercial concentrated hydrochloric acid, yielded 90% of the silver to the solvent.

SHORT NOTICES

Cable Conveyor.—In *Engineering* for November 19, G. F. Zimmer describes the cable conveyor, invented by J. Pearce Roe, of Ropeways, Ltd. This machine is a type of continuous conveyor built on the ropeway system.

Aerial Ropeway.—The *Iron and Coal Trades Review* for October 29 contains a full description, with illustrations, of an aerial ropeway at the Frickley colliery, built by R. White & Sons, Widnes.

Supports in Mines.—The *Iron and Coal Trades Review* for November 5 prints a paper by John Swan, read before the National Association of Colliery Managers, on methods of supporting roof and sizes in drifts and working places in mines.

Wire Ropes.—The October *Journal* of the South African Institution of Engineers contains a paper by G. W. Westgarth on wire ropes, their manufacture, defects, etc. In particular he described his own rope, in which each strand rests on a wire of crescent-shaped cross-section, which in turn rests on the usual hemp core.

Silver Extraction.—In the *Engineering and Mining Journal* for November 6, J. A. Carpenter writes on the extraction of silver from manganese-silver ores, advocating chloridizing-roasting followed by cyaniding.

Estimation of Bismuth.—At the meeting of the Chemical Society held on November 3, W. R. Schoeller and E. F. Waterhouse read a paper describing a modification of the method for the gravimetric estimation of bismuth as phosphate.

Copper Converting.—At the November meeting of the Institution of Mining and Metallurgy, H. C. Robson presented a paper describing converter practice at Spassky, where magnesite-lined converters were introduced instead of acid-lined converters. The matte treated was of high grade.

Electro-deposition of Cobalt.—At a meeting of the Faraday Society held last month at Sheffield, H. Byron Carr read a paper on the electro-deposition of cobalt as a protective coating for other metals.

Arsenic.—In *Chemical and Metallurgical Engineering* for November 17, Chester H. Jones describes the production of metallic arsenic at Chicago by the Hoskins Process Development Company.

Molybdenite in New Mexico.—In *Economic Geology* for November, E. S. Larsen and C. S. Ross describe molybdenite deposits in Toas County, New Mexico.

Pyritic Deposits.—In *Economic Geology* for November, George Hanson discusses the origin of various pyritic deposits in metamorphic rocks, making special reference to the deposits in Northern Manitoba, the North Pines deposit in Ontario, and the Eustace mine in Quebec.

Norwegian Mining.—In the *Engineering and Mining Journal* for October 30, M. R. Bish writes on the mining and metallurgical industries of Norway.

Ochre in Georgia.—In the *Engineering and Mining Journal* for October 30, Marshall Haney describes the yellow ochre deposits at Cartersville, Georgia.

El Tigre.—In the *Mining and Scientific Press* for October 23, R. T. Mishler describes the geology of the El Tigre silver-gold mine, in Sonora, Mexico.

Congo State.—In the *Engineering and Mining Journal* for October 23, Sydney H. Ball and Millard K. Shaler write on the present position of mining in the Belgian Congo.

Colloidal Fuel.—At the meeting of the Institution of Petroleum Technologists held on November 16, Lindon W. Bates and Haylett O'Neill presented papers on colloidal fuel, which consists chiefly of heavy oil in which is suspended powdered coal.

Aluminium Dust.—In *Chemical and Metallurgical Engineering* for November 10, D. J. Price describes an explosion of aluminium dust at a factory where household utensils were made of this metal. The dust was created in the department where bright finish was given and it was drawn away by a fan. The dust caught fire in the fan and the result was an explosive effect.

RECENT PATENTS PUBLISHED.

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 1s. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.2., with a note of the number and year of the patent.*

20,840 of 1918 (121,730). C. ROSSI, Legnano, Italy. Method of preparing pure alloys of iron and silicon suitable for use where acid-resisting receptacles are required.

9,489 of 1919 (152,051). Sir OLIVER LODGE, L. LODGE, and the LODGE FUME DEPOSIT CO., LTD., Birmingham. In apparatus for the electrostatic precipitation of solid or liquid particles from gases, improved depositing chambers of the type in which discharge electrodes are arranged transversely across channels formed between parallel metal plates.

14,833 of 1919 (130,320). AKTIESELSKABET STORDO KISGRUBER, Stord, Norway. An improved discharge for concentrates in jigs.

15,026 of 1919 (151,684). COMPAGNIE DES PHOSPHATES DE CONSTANTINE, Paris. Method of enriching natural phosphates.

15,452 of 1919 (151,689). H. S. BROOM, High Wycombe. Improved valve for air-compressors.

16,514 of 1919 (152,073). T. ROUSE, London. In agglomerating fine iron ore, to be smelted in an electric furnace, the use of a modified ferro boro-silicate, which acts as a reducing agent as well as an agglomerant.

16,856 of 1919 (152,395). JOHN REES, Bridgend, Glamorgan. A combined gauge and measuring rod for use in mines.

16,936 of 1919 (151,747). T. CRANSON, Blackhall, Durham. Apparatus for preventing the fall of a mine cage on the failure of a winding rope.

17,113 of 1919 (152,398). N. L. HALL, Salt Lake City. In ball-mills or tube-mills, one or more partition walls arranged longitudinally, having a cut-away portion at each end adjacent to the inner ends of the hollow trunnions, adapted to constitute communicating mediums between the compartments of the drum.

17,190 and 20,201 of 1919 (152,399). W. B. BALLANTINE, London. Reducing chromic acid to chromium by reaction with calcium carbonate in the presence of an oxide with an earthy base.

17,246 of 1919 (152,401). E. A. ASHCROFT, London. Method of removing water of hydration from crystalline magnesium chloride.

17,247 of 1919 (152,402). E. A. ASHCROFT, London. Electrolytic method of decomposing anhydrous magnesium chloride for the production of magnesium and chlorine.

17,248 of 1919 (152,403). E. A. ASHCROFT, London. Method of production of magnesium or magnesium alloys, with magnesium chlorate as a by-product.

17,922 of 1919 (152,441). INTERNATIONAL EARTH-BORING MACHINE CO., Chicago. Improved vertical earth-boring machine.

17,929 of 1919 (152,752). F. PETERSSON and METALS EXTRACTION CO., LTD., London. Method of removing silica from solutions in the electrolysis of zinc salts.

18,247 of 1919 (152,780). P. B. CROSSLEY, Calcutta. Method of utilizing waste mica, asbestos, etc., in the production of a non-fragile glass.

18,255 of 1919 (152,447). C. G. COLLINS, Woodmere, New York. Method of precipitating sulphur from the gases of roasting and smelting furnaces.

18,311 of 1919 (152,785). GENERAL ELECTRIC CO., Schenectady, New York. Boilers for vapourizing mercury and other liquids having a high boiling-point.

18,584 of 1919 (130,978). J. REOL, Lyons, France. A vertical drying or calcining furnace.

19,601 of 1919 (153,113). PENNSYLVANIA SALT MANUFACTURING CO., Philadelphia. Manufacture of basic sulphate of zirconium, as a step in the production of pure zirconium oxide.

19,612 of 1919 (152,815). S. H. COCKS, London. Improved amalgam press.

20,020 of 1919 (152,466). W. S. LILLY, Tacoma, U.S.A. Automatic control mechanism for winding engines.

20,496 of 1919 (153,131). H. S. BROOM, High Wycombe. Improved driving gear for air-compressors.

21,039 of 1919 (131,897). DEUTSCHE MOLYBDAEN-WERKE, Halle, Germany. Method of extracting molybdenum from wulfenite (molybdate of lead).

NEW BOOKS, PAMPHLETS, Etc.

☞ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London Wall, E.C.2.

Steam Shovel Mining. By ROBERT MARSH, JR. Cloth, octavo, 258 pages, with many illustrations. Price 23s. net. New York and London: McGraw-Hill Book Co.

Those engineers are fortunate who have a hobby which coincides with the demands of their profession. Such a coincidence would seem to exist in this case; and a useful book is the result. It is a pity that mining men do not more frequently make public the valuable data they collect and the conclusions they reach with regard to the phases of mining to which they more particularly devote themselves and concerning which they acquire special knowledge. The usual excuses put forward for the non-performance of this professional task are want of time and want of practice in writing. Seen distantly, these are terrifying obstacles; viewed closely, they are found to be of the order of everyday difficulties, of which no one need be the least bit afraid. The author, for the benefit of his fellow engineers, here tabulates and submits to critical analysis the information on the application of the power shovel in mining which he has accumulated through reading, travel, and the supervision of open-pit working. He divides his subject into the following eight sections: The power shovel, mechanical equipment, methods of attack, drilling and blasting, disposal of material, the determination of a power shovel mine, cost of shovel work, and administration.

Taking a leaf out of the book of the metallurgist, who borrowed the tube-mill from the cement manufacturer, the miner has borrowed the steam shovel from the railroad contractor. In both instances the new duties thrust upon the requisitioned appliance have led to pronounced improvements in its design. The steam shovel was employed to a limited extent in 1865; generally in 1884; for stripping overburden from mines in 1887; and for mining ore in 1892. It is largely used in the iron ore mines of the Mesabi range of Minnesota, the shallow coal deposits of Kansas and Illinois, the magnetite mines of Sweden, the copper mines of the Belgian Congo, and in the mines of the Utah Copper, Chino Copper, Nevada Consolidated Copper, Chile Copper, Rio Tinto, and Mount Morgan. Under suitable conditions it yields enormous outputs at low tonnage costs; so low that a few years ago they would have been considered impossible; with resulting beneficiation of many huge bodies of low-grade ore hitherto regarded as little better than country rock. This open-pit type of mining possesses certain marked advantages. No valuable ground is locked up in pillars or lost by crushes. There are no underground workings to be kept open and in repair. The danger of fire is absent; ventilation and lighting present no problems, and the health of the workers is better. Large faces and blasts make for economy and for easy control of output. Against these favourable factors may be placed delays due to bad weather, and the time taken and the heavy expense incurred in removing the overburden. The price of a power shovel appears to range from $5,000 for a machine weighing 18 tons to $70,000 for one, electrically equipped, weighing 250 tons. The average working capacity may be put down at 2,000 tons a day, and the working cost, including stripping, supervision, taxes, etc., at 60 cents a ton.

A very interesting chapter is that on the determination of a power shovel mine. A low-grade copper orebody, covering 30 acres, 96 ft. thick, under an overburden 245 ft. thick, is considered. The competitive methods of working the deposit by means of top-slicing, shrinkage-stoping, block-caving, and branch-raising are carefully gone into, and their advantages and disadvantages balanced against those of the shovel method. Only brief mention is made of machines adapted for shovelling underground or "shovel-loaders," and this mention is not of a laudatory character. These machines, which operate in stopes and drifts, will no doubt follow the law of the survival of the fittest or other evolutionary development, just as the rock-drill did. Such development should be encouraged, in view of the fact that of the total hours worked by the underground force in metal mines some 37% is spent in shovelling, the rest being absorbed by tramming, drilling and blasting, timbering, and so on. The "mucking" problem in underground work being therefore of some moment, it is deserving of more attention than is usually accorded to it. The book is well produced, is concisely and lucidly written, and is to be recommended to any one desirous of obtaining reliable information on a system of mining which is of growing importance.

ALEX. RICHARDSON.

Casing Troubles and Fishing Methods in Oil Wells. By THOMAS CURTAIN. Bulletin 182 issued by the United States Bureau of Mines.

Manganese Ore in Nevada. By J. T. PARDEE and E. L. JONES. Bulletin 710F issued by the United States Geological Survey.

Metal Mine Accounting. By C. B. HOLMES. Technical Paper 250 issued by the United States Bureau of Mines.

Commercial Minerals of California. By W. O. CASTELLO. Bulletin 87 of the California State Mining Bureau.

Mineral Determination. By H. R. BERINGER. Pamphlet, 100 pages. Price 4s. Camborne: Camborne Printing and Stationery Company.

Notes on Geological Map-Reading. By ALFRED HARKER. Pamphlet, 64 pages, illustrated. Price 3s. 6d. net. Cambridge: W. Heffer & Sons, Ltd.

The Sunset-Midway Oilfield, California. By R. W. PACK. Part 1, dealing with geology and oil resources. Professional Paper 116 issued by the United States Geological Survey.

The Oil Shale Industry. By Dr. VICTOR C. ALDERSON. Cloth, octavo, 180 pages, illustrated. New York: F. A. Stokes Company.

COMPANY REPORTS

Scottish Spitsbergen.—This company, which is controlled in Edinburgh, has issued a circular giving some of the results of prospecting during the past summer, obtained by the expedition consisting of John Mathieson, J. M. Wordie, Robert Campbell, G. W. Tyrrell, A. F. Campbell, and assistants. The details given relate to the Ebba Valley and Bruce City coalfields. The Ebba Valley coalfield is situated immediately to the north of Adolf Bay, and the area proved extends to 3 square miles. Investigations have established the fact that two seams traverse this coalfield, and that the lower seam is a very good one. The thickness of this seam is 4 ft., of which 3 ft. 3 in. is quite workable, and there is a progressive thickness in the coal strata, including the coal itself, to the westward. In No. 3 excavation, which was made last year, the measurements, after the cutting was cleaned out this summer, practically coincided with the measurements made last year. Altogether about 7 ft. 4 in. of coal are visible in this excavation. If the coal maintains its workable thickness of 3 ft. as indicated in the mine section, the amount of coal above sea-level in this region may be estimated at about 8,250,000 tons. If the seam be followed down to 500 ft. below sea-level the above amount is approximately doubled, that is, 16,500,000 tons for the 3 square miles. As regards quality, the coal is a hard, clean-looking material, with a semi-anthracitic lustre. It cokes and burns well in a good draught, giving great heat. In stove burning there appears to be a considerable quantity of fine white ash, but an analysis of a sample from one of the seams brought back by one of the directors shows only 3·40% ash, with fixed carbon 66·30%, volatile 28·52%, and sulphur 0·36%; calories 7,985, equal to 14,373 B.T.U. The coal produces a hard coke which appears to be of excellent quality. The Bruce City coalfield lies immediately to the east of Klaas Billen Bay, and extends over the area lying between the Gerrit River on the north and the Ekholm River on the south, and contains approximately 11,700 acres. Two coal seams exist in this field, namely, the upper, or Carron (A), and the lower (B). The two coal seams are separated by about 60 yards of intervening strata, mainly sandstones. The Carron seam ranges from 2 ft. 3 in. to 3 ft. 4 in. in thickness, and is 2 ft. 10 in. thick in No. 5 bore. This seam was passed through in bores No. 3 and No. 5. In bore No. 3 the Carron seam was struck at a depth of 80 yards, and the lower was struck in bore No. 5 at 106 yards deep. The lowest of those seams in all probability corresponds to a seam of similar character known to occur in this territory to the south and west of the area, and therefore may be regarded as likely to continue over the whole of the Bruce City coalfield. The following is an analysis of the sample of the Carron seam : Fixed carbon 56 25%, volatile 23·38%, sulphur 0·78%, ash 18·07% ; coke % 74·90, lb. per ton 1677·8, percentage of ash in coke 24·12, calories 6,490, equal to 11,682 B.T.U. The above analysis was made from an outcrop sample. The analysis of such a sample is not a true test of the actual quality of the coal in the seam, as it has been exposed for a very long period to the influence of the weather. On the assumption that the workable thickness in each case is 2 ft. 10 in., and that the seams maintain their thickness to the dip, it is estimated that this field contains 8,000 tons of workable coal per acre, equal to about 90,000,000 tons for the whole of the area. The Carron seam appears at the surface 200 ft. above sea-level at the Carron River ; the outcrop of the lower seam is there concealed under the edge of the Nordenskjold Glacier, but the chief seam has been located in No. 5 bore at a depth from the surface of 106 yards. The depth will increase slowly with the dip in a south-westerly direction, until at the Ekholm Valley the coal seams should be found at a depth of from 300 to 400 yards. The configuration of the ground is reported to be admirably adapted for the erection of mining plant ; and the depth of water close inshore at convenient points renders the problem of shipment of coal a simple one.

Simmer & Jack.—This company belongs to the Consolidated Gold Fields group, and has worked an outcrop mine in the middle east Rand since 1887. The report for the year ended June 30 last shows that 621,300 tons of ore was raised and sent to the mill. The yield of gold by amalgamation and cyaniding was 153,246 oz., realizing £812,297, of which £161,933 was premium. The working cost was £706,748, leaving a working profit of £105,549. The yield per ton at par was 20s. 11d., and with the premium 26s. 1d., while the cost per ton was 22s. 9d. It will be seen that but for the premium a loss would have been incurred. The dividend, declared in January last, absorbed £75,000, being at the rate of 2½%. The ore reserve at June 30 was estimated at 1,230,000 tons averaging 5·53 dwt., as compared with 1,318,000 tons averaging 5·83 dwt. the year before. During the year a new system of payment to white labour has been devised, whereby cleaner mining is obtained without any serious reduction of the total tonnage.

Welgedacht Exploration.—This company was formed in 1899 to acquire property in the Far East Rand, east of Geduld. In 1905, the gold-bearing banket beds were proved by bore-holes, but shaft-sinking was interrupted by water troubles. The operations of the company were then directed to developing the coal deposits discovered during boring. For some years there was a regular output, but in April of this year the colliery was closed owing to adverse working conditions and poor results of development, and the plant has been sold. The report for the year ended June 30 shows that 134,177 tons of coal was sold, realizing £40,679, against a working cost of £46,272. The company holds the owner's gold-mining rights, but the time has not yet come for development of this area.

Middleburg Steam Coal & Coke.—This company was formed in 1902 to acquire coal lands in the Middelburg district of the Transvaal. The report for the year ended June 30 shows that the output of coal was 331,960 tons, as compared with 281,666 tons the year before. This increase is due to improvements made in the plant, in particular the provision of electric coal-cutters. Additional coal-lands have been acquired, and a new incline shaft has been sunk. It is expected that next year the output of coal will show a still further advance. The accounts show a profit of £25,759, out of which £793 is paid as debenture interest, £3,244 as preference dividend, and £9,988 as ordinary dividend at the rate of 10 per cent.

Glynn's Lydenburg.—This company was formed in 1895 to acquire a group of gold mines on the Sabie River, near Pilgrim's Rest, in the Lydenburg district of the Transvaal. The control is with the Central Mining group, and G. C. Damant is manager. The report for the year ended July 31 last shows that 39,554 tons, averaging 8·4 dwt. per ton, was sent to the mill, and that the yield by amalgamation and cyanide was 15,332 oz., or 7·75 dwt. per ton. The gold realized £79,639, of which £17,055 came from premium. The working cost was £65,438. It will be seen that but for the premium a loss would have been made. Dividends at the rate of 10% have been paid, absorbing £17,000. The yield per ton has shown a decrease, comparing with 8·88 dwt. the year before. The developments also have disclosed ore of lower average grade, the reserve on July 31 being 134,870 tons averaging 8·3 dwt., as compared with 108,546 tons averaging 9·4 dwt. the year before. The manager complains of the scarcity and inefficiency of labour, which make it impossible to keep the plant going to full capacity.

Gaika Gold.—This company was formed in 1902 by the Rhodesian Exploration & Development Co., to acquire a gold mine near the Globe & Phœnix, in the Sebakwe district of Rhodesia. The control passed to the Gold Fields Rhodesian Development Co. in 1912. Milling started in 1905, and dividends have been paid since 1911. The report for the year ended June 30 last shows that 36,724 tons of ore averaging 9·05 dwt. per ton was sent to the mill, and that the extraction of gold was 9,165 oz. by amalgamation and 5,488 oz. by cyaniding, making a total of 14,653 oz. In addition the treatment of accumulated sand and the sale of slags to the Falcon smelter brought the total yield of gold to 15,094 oz. This gold realized £80,173, of which £16,797 represented premium. The working cost was £50,247, and the net profit, after allowance for depreciation, was £28,996. The dividend absorbs £20,512, being at the rate of 7½%. The reserve is estimated at 64,000 tons averaging 15·7 dwt., as compared with 60,000 tons averaging 12·4 dwt. the year before, the increase being largely due to the results of development on the Rubble reef. In the north drive at the 2nd level the ore for a distance of 120 ft. averages 29 dwt. over 46 in. ; on the 3rd level in the north drive for a length of 180 ft. the ore averages 21·9 dwt. over 128 in., and in the south drive for a length of 120 ft. the ore averages 42·1 dwt. over 37 in. In winzes below the 3rd level the rich ore continues for some distance down, but faulting has interfered with further development. At 50 ft. down the ore averages 7½ to 10 dwt. over 10 to 12 ft. In No. 4 level no ore in any continuous length has been found so far.

Malayan Tin Dredging.—This company was formed in 1911 to acquire alluvial tin properties near Batu Gajah, in the Kinta district of Perak, Federated Malay States. It belongs to the same group as the Tronoh and Lahat companies. The report for the year ended June 30 last shows that the four dredges treated 2,558,500 cu. yd. of ground for an output of 594 tons of tin concentrate. These figures compare with 3,256,540 yards and 702 tons for the previous year. This fall is due to many stoppages for repairs. The yield per yard was 0·52 lb. as against 0·48 lb. the year before. The concentrate sold for £110,681 as against £109,957 the year before, and the profit was £31,279. The dividends distributed during the year totalled £36,000 or 20%. There has been considerable delay in building the two new dredges provided for some time ago, but it is hoped that shipments will commence about the end of this month. During the year 114 acres of land has been acquired, bringing the total area to 1,697 acres.

Kamunting Tin Dredging.—This company was formed in 1913 as a subsidiary of F.M.S. Timah, Ltd., to work an alluvial tin property in the Larut district of Perak, Federated Malay States. The report for the year ended June 30 last shows that the dredge treated 948,500 cu. yd. of ground and extracted 349½ tons of tin concentrate, the yield per yard being 0·77 lb. The revenue from the sale of concentrate was £59,967, and the net profit, after allowance for amortization of capital, was £23,802. The allowance for income tax was £5,468, but against this is the item £3,986, recovered on account of previous payments for excess profits duty. The shareholders received £21,383, being at the rate of 10%. The total working cost including amortization was at the rate of 9·43d. per yard. As recorded last January, 130,000 £1 shares were sold to shareholders at 30s. each, for the purpose of providing two new dredges. The contract for these dredges has been placed. The capacity of each dredge will be 100,000 cu. yd. per month.

Naraguta (Nigeria) Tin Mines.—This company was formed in 1910 to acquire alluvial tin ground at Naraguta, Nigeria. Additional properties have since been acquired, at Karama in the Ninkada district, at Sho near Zungeru, and at Korot. F. N. Best is chairman, C. G. Lush is consulting engineer, and F. O'D. Bourke is manager. The report for the year ended July 31 last shows that 420 tons of tin concentrate was recovered, as compared with 433 tons the year before. Prospecting in the Korot area has given excellent results. The accounts show an income of £78,956, and a profit of £22,119, out of which £17,500 was distributed as dividend, being at the rate of 10%.

Forum River (Nigeria) Tin.—This company was formed in 1912 by the Northern Nigeria Trust to acquire tin properties on the Forum, Du, and Bukeru rivers. A. W. Hooke is the manager. The report for the year ended March 31 last shows that the output of tin concentrate was 149 tons, as compared with 220 tons the year before, the fall being due to the scarcity of labour. The income was £27,779, and the net profit was £6,051, which is carried forward. The company is to be amalgamated with the Bisichi and others, as set out in Review of Mining.

Ninghi (Nigeria) Tin.—This company was formed in 1912 to work alluvial tin ground in the Ninghi district of the Bauchi Province, Nigeria. These properties were abandoned, and other properties, including the Ribon Valley, were afterward acquired from the Niger Company. The report for the year ended March 31 last shows that the output was seriously curtailed by lack of labour, the amount of tin concentrate won being only 88¾ tons, as compared with 102 tons and 157½ tons in the preceding years. The income from the sale of concentrate was £23,012, and the result of the year's work was a loss of £2,074. This company is to be amalgamated with the Forum, Bisichi, and others.

Oriental Consolidated.—This company was formed in 1897 in the United States to work a group of gold mines in the Unsan district, Korea. Henry C. Perkins is chairman and A. Welhaven is manager. Dividends have been paid since 1903. The report for the year ended June 30 last shows that 233,323 tons of ore averaging \$5·82 per ton was sent to the mill, coming from the individual mines as follows: Tabowie, 128,405 tons, averaging \$6·40 per ton; Taracol, 97,647 tons, averaging \$4·72; Chintui, 4,811 tons, averaging \$4·78; Tongkol, 2,460 tons, averaging \$20·69. The yield by amalgamation was \$569,198, and by the cyaniding of concentrates \$563,003, making a total of \$1,132,201, or \$4·85 per ton. The working cost was \$856,967, and \$306,610 was written off for depreciation and depletion, leaving a profit of \$25,052. A dividend of 5%, absorbing \$214,695, was paid in March last. The year's working was interfered with by prolonged drought, which also prevented the new hydro-electric plant coming into full use. Development at Tabowie has continued to give poor results, and the reserve is estimated at 384,000 tons averaging \$5·43 per ton, as compared with 441,000 tons averaging \$5·44 the year before. The developments at Taracol have been encouraging, and the reserve stands at 345,000 tons averaging \$4·60, as compared with 260,000 tons averaging \$4·54 the year before. Chintui and Tongkol continue to yield small amounts of ore, and developments at other properties have been continued, without any very important results.

El Oro Mining & Railway.—The report of this company for the year ended June 30 last shows that 366,730 tons of ore was raised and treated, averaging \$6·00 in gold and \$2·77 in silver. The yield by amalgamation and cyaniding was \$2,789,457, equal to \$7·61 per ton, of which \$1,984,926 was in gold and \$804,531 in silver. The percentage of recovery of gold was 90 and of silver 79. The working cost was \$2,439,172, or \$6·65 per ton, leaving a working profit of \$326,909, equal to \$0·96 per ton, or in English currency, £81,727. After the deduction of costs and taxes in London, the net profit was £62,946, out of which £57,375 was distributed as dividend, being at the rate of 5%, tax paid. The reserve is estimated at 293,779 tons averaging \$11·27 in gold and 2·71 oz. silver per ton. The Descubridora vein is likely to add considerably to the reserve. Examinations have been made of two new properties which offer inducement for serious development. Other properties are also the subject of negotiation.

Weardale Lead.—This company was formed in 1883 to work a group of lead mines near the head of the river Wear, in the county of Durham. The galena is found in the Carboniferous Limestone and is associated with fluor-spar. The report for the year ended September 30 shows that 2,774 tons of lead concentrate was produced and sold, together with 11,699 tons of fluor-spar. The net profit, after provision for taxes, was £10,841. The sum of £4,957 was recovered from previous payment of excess profits duty. The dividends absorbed £12,239, being at the rate of 12½%. Of the lead concentrate produced during the year, 2,553 tons came from the Boltsburn mine, 163 tons from the Stanhopeburn, and 42½ tons from the Sedling. Of the fluor-spar, 4,452 tons came from Stanhopeburn, 4,058 from Sedling, and 864 from Boltsburn. The output of fluor-spar was the highest on record.